DEGLUTITION AND RELATED SPEECH PERFORMANCE IN NORMALS AND SPASTIC CEREBRAL PALSIED

Register No.M8803

A DISSERTATION SUBMITTED AS PART FULFILMENT OF FINAL YEAR M.Sc., (SPEECH AND HEARING) TO THE UNIVERSITY OF MYSORE.

ALL INDIA INSTITUTE OF SPEECH AND HEARING: MYSORE - 570 006

MAY 1990

The mediocre teacher tells.
The good teacher explains.
The superior teacher demonstratesbut

THE GREAT TEACHER INSPIRES

DEDICATED TO

MY GUIDE,

MY MENTOR.

CERTIFICATE

This is to certify that the Dissertation entitled: DEGLUTITION AND RELATED SPEECH PERFORMANCE IN NORMALS AND SPASTIC CEREBRAL PALSIED is the bonafide work in part fulfilment for the degree of M.sc.,(speech and Hearing) of the student with Register No.M8803.

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CERTIFICATE

This is to certify that this Dissertation entitled: DEGLUTITION AND RELATED SPEECH PERFORMANCE IN NORMALS AND SPASTIC CEREBRAL PALSIED has been prepared under my supervision and guidance.

Manjula. R

GUIDE

Mysore

May, 1990

DECLARATION

This Dissertation entitled: DEGLUTITION AND RELATED SPEECH PERFORMANCE IN NORMALS AND SPASTIC CEREBRAL PALSIED is the result of my own study undertaken under the guidance of Mrs.R.Manjula, Clinical Lecturer, Department of Speech Pathology, All India Institute of Speech and Hearing, Mysore and has not been Submitted earlier at any University for any other Diploma or Degree.

Mysore

May, 1990 Register No.M8803

ACKNOWLEDGEMENTS

Words cannot express...

HEARTFELT GRATITUDE to my teacher and guide, Mrs.R.Manjula, Clinical Lecturer, AIISH, Mysore for the stimulus of her infectious enthusiasm in launching the Shuttle of my Quest, giving it an escape velocity, charting its trajectory and helping complete this venturous voyage. IOU, Ma'am for your sustained counsel,guidance and support and making my love for CP a high probability event.

Sincere thanks to the Director, AIISH, Mysore for permitting me to embark on this study.

Thanks to Dr.P.Karanth, Prof, and HOD. Department of Speech Pathology, for permitting me to undertake this study.

Sincere thanks to Dr.Shyamala Changappa, for providing me with the valuable foundation in this subject? to Dr.s.R.Savithri, and Dr.J.Bharath Raj. for the timely guidance: to Mrs.Prema, Mrs.Geetha, Mrs. Indira Prakash and Mrs.Vijayashree for directing me to my potential subjects and sources of information? to Dr.s.Natarajan, Dr.Murugan and Mr.Anjaneyulu for their constructive suggestions and myriad help and to Mom, Dad, Pati, Mohan and ehm, Dr.Kiran Natarajan for the vast and varied help and the tonic of vigour provided in every stage of this work. Thanks Didi and Jijaji for that you mean to me.

I am indebted to Mrs.Latha Murthy and all the.parents of the CP case who have tought me much more than I've taught them. Kudas lil kiddos jj u've made my dream come true. Thanks to you, a special thanks to Jitu and shivi and all my supra patient subjects for having so willingly lent me your oral cavity for the peep shows.

I am indebted to my colleagaes Yamini, Vidya, Sonu, Maya, Suresh Bhat, Kiran, Indu, Lakshmi, Poornima, Vinay, Ramkishan, and Bijay for having given me their views on my views and for their constructive suggestions provided in the write up of this work.

Setting me on the move, when my brain refused to budge, with the invigorating 'Newtonic' motivation, that was my walking thesaurus-Satya's terrific job and to her goes a special word of THANKS.

I owe lot to all the III BScs, especially Sowmya, and Jenyy Alka, Vanita, Krishnamala and Rasita for the timely help rendered during the developmental stages of this developmental profile.

Thanks to the Library staff, AIISH for the help with the 'Literary treasure hunt'? Mrs.Swraswathi, General Hospital, Neyveli? Dr.Kiran Natarajan, KMC, Madras, Dr.shoba, Madras Central College, who placed their valuable literature at my disposal.

THANKS to My.Rajalakshmi R Gopal, patience personified for the industrious, neat, supersonic HALDA ic typing.

I am indebted to the DDS-Jayanthi, Susan, Sarumathi, and Sheeba for the unflailing assiduous help rendered, making the low probability STATS DREAM a dynamic reality. Thanks pals, this venture could not have been completed Bat for the pure luck I've had specific to having great friends like you, and often being at the right place to feel needed.... for which I thank my stars too.

And finally, SORRY, dear chinnu, for having seized so much of your time from mamma.

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INTRODUCTION

The service oriented milieu of speech pathology calls attention to, among many others, the multiply handicapping condition of cerebral palsy. Alleviation of the deviant oral motorium evidenced by the complex symptomatology of dysarthria, demands an insight into the oral physiology, including the complex, continuous, automated act of deglutition. This vital act of deglutition of nutritive value refers to "... the process whereby a bolus, liquid or solid, is transferred from the buccal cavity to the stomach" (Lund, 1987). It comprises of -

(i) The oral stage

(ii) The pharyngeal stage and

(iii) The esophageal stage (Magendie, 1816).

"Eating and speech have manifold connections in anatomical, physiological, pathological and psychological sense" (sittig, 1951). This is evidenced in the fact that oral pharyngeal dysphagia and dysarthria coexist in the cerebral palsied despite a lack of clearcut relationship between the two (Ingram, 1962; Sheppard, 1964l; Bosma, 1975; Love, Hagerman and Taimi, 1980; Hardy, 1983).

The universal prescription of oroneuromotor training for the cerebral palsied have been based on the premise that

i) the two acts——deglutition and speech develop in parallel.

ii) or subserved at least in part by different neuronal structures (Netsell, 1986).

This highlights the importance of a search into the area of deglutition in relation to amelioration of dysarthria, enlisting the deviances/delay in maturation of the first two phases of deglutition so as to have a finesse to our therapeutic regime. The basis for this is obtaining a developmental profile in lieu of the maturational influence of rapid facial and oral morphological changes and of corresponding rapid changes in vegetative and social demands. This area is still in its incipient stages, the plausible reasons being:

i) A dirth of instrumentation in our clinical set up like EMS, cine-radiography, videoflurography, etc.

ii) A possible notion that this field is beyond the circumscription of speech pathology and speech sciences.

Speech pathology, addressing the general motorium and in specific, articulation and vegetative intraoral act of deglutition, beckons a multidisciplinary team approach of physiotherapist, occupational therapist and the medical professional. This increases the professional urgency in Indian set up, wherein a transdisciplinary approach, based on the principles in clinical practice from allied professionals is most often being utilized.

The other cogent features of deglutition apart from the vegetative theaapy for cerebral palsied include -

i) Froeschls chewing technique as applied to -
   - cerebral palsy for reduction of drooling
   - stuttering
   - misarticulation
   - voice therapy

ii) Muscle training for cleft palate, dysarthrics and other neuromotor speech disorders.

iii) Mechanism of air intake for esophageal speech etc.

The present study is an attempt to explore the field of deglutition in relation to the speech performance skills of articulation and voicing in normal adults, children and spastic cerebral palsied.

Objectives: Objectives of this study include:

i) Obtaining a developmental profile of deglutition baaed on direct visual observation and representing the data using a semiquantitative scale.

ii) To gauge the status of deglutition in the cerebr*l palsied, highlighting the deviances (or otherwise) noted from the normal controls, thereby attempting to accentuate the homogenity in the otherwise heterogenous condition of cerebral palsy.

iii) To study the extent of relationship between deglution and speech skills (articulation, and voicing) in normals and spastic cerebral palsied.

Hypotheses:

1. There is no difference in the eating habits (oral and pharyngeal phases of deglutition)and speech skills in normal children of different age groups and normal adults.
2. There is no difference in the act of oral - pharyngeal deglutition and speech in spastic cerebral palsied and normals.
3. There is no relationship between the motor acts of deglutition and speech.

Brief Plan of the study:

The study will be conducted in four stages.

1. Development of the test protocol.
2. Administration of the test.
3. Rating the responses obtained
4. Analysis of the data

Development of the test protocol;

Based on the literature and a pilot study on normal adults and children, the test format will be constructed, assessing the oral and pharyngeal phases of deglutition and speech. The food items will be relected so as to -

i) Incorporate a range of consistency from liquids to solids, typifying a regular diet to check on the intcaoral bolus manipulation.

ii) Be easily accessible for testing.

Administration of the test:

The test format contrived will be administered to three groups of subjects - - normal adults, normal children and verbal, normal hearing spastic cerebral palsied. Suitable controls and modification in administration of the test to the specific groups will be adapted depending on the need.

Development of semiquantitative scale:

A semiquantitative scale will be utilized to rate the performance of the subjects on the deglutition tasks (eating and drinking).

Analysis of the data collected:

The raw data obtained will be subjected to statistical analyses and the results discussed.

Implications:

(i) The study is directed at exploring the practical application of the developmental data to the cerebral palsied population to 'normalize' or 'regularize' the components of deglutition and thence increasing the physiological readiness for speech.

(ii) The data may be extended to other clinical populations like the neurogenic communication problems of dysphasia and dysarthria, and air injection technique for the laryngectomees.

REVIEW OF LITERATURE

I. SPEECH VERSUS VEGETATIVE ACTS- COMPARED:

The definitive role of speech therapists in a program for rehabilitation of the multiply handicapped cerebral palsied demands a realistic orientation to the currently used oro-neuromotor training techniques and identification of both discrete and inter-related areas of development responding to treatment. This calls for a critical appraisal of the statement. IS SPEECH AN OVERLAID FUNCTION? scanning the literature, we find several lines of evidence hypothesizing that speech and vegetative movements develop.

i) in parallel;

ii) subserved at least in part by different neuronal structures. (Netsell, 1986).

These are discussed with the view that communication system comprises of the following four components:-

(i) Peripheral apparatus with its anatomical properties which generates species specific signals.

(ii) Its cerebral motor control system which does the patterning of the signal.

(iii) Sense organs which receives the species specific signal (interms of the physical energy).

(iv) Cerebral decoding apparatus which transforms the signal into a message which may or may not produce a modification of behaviour on the receiver's end.

The four are stated to be interdependent.

The current section highlights the anatomical, physiological and psychological relationship between the two motor acts of speech and deglutition.

Anatomical correlation;

Central and peripheral anatomical structures (neuronal, vascular,musculoskeletal system) are identical, implying a deep rooted connection in the physiology of the two functions. For instance, larynx developed, in evolutionary terms first as sphincter to protect the respiratory thact from aspiration of food by the sphincteric action of lateral cricoarytenoid and aryepiglottic muscles. It subsequently developed a secondary function in phonation (Stark , 1985).

The lower part of precentral gyrus regulates the chewing and speech movements, evidenced from the clinical findings of clients with lesion in this region, exhibiting dysphagia and dysarthria. Cerebral palsy belongs to this category. Deeper anatomical correlations are made from patients with brain lesion exhibiting chewing movements when attempting to speak, which is explained by the identity of the centres for these two functions (Weiss, 1951).

Foerester, cited by Weiss (1951) showed that electrical stimulation of the lower third of the precentral gyrus of man (area 66) results in the following reactions: rhythmically coordinated movements of lips, tongue, jaw and soft palate, further rhythmical chewing and licking movements and loud smacking, grunting and groaning.

Cushing , cited by Weiss (1951) was able to obtain regular voicing by stimulating the same area.

Existence of the above correlation have been refuted in lieu of the findings that -

(i) Biting and chewing depend more on the powerful pincer effects resulting from contraction of masseter, temporals and pterygoid muscles. These receive their motor supply separately via the motor subdivision of the mandibular branch of trigeminal nerve, and their central connections being to the masticatory nucleus and not the nucleus ambiguus. Regardless of their loci, the speech and vegetative neural commands are conceived as parallel inputs that would compete at some level of neuraxis for the final effector neurons, if issued simultaneously. It is generally assumed that speech commands originate in the cerebral cortex and vegetative acts are triggered from external stimuli or suboortical neurons (Netsell, 1986).

(ii) The muscles involved in jaw jerk are not important in articulation.

(iii) Sensation from the pharynx, larynx and gut is transmitted via afferent fibers in the 7th, 9th, and 10th cranial nerve which relay to the main sensory nucleus-of the bulbar region - the nucleus of tractus solitarius. Another important brainstem nucleus unimportant for speech is the salivary nucleus which projects visceral motor - afferent nerves via several different cranial nerves to the salivary glands (Netsell, 1986).

Other evidences relate to the embryonic and postnatal neural development suggestive of the existence of separate micro-neuroanatomy for speech.

(a) <u>Embryonic differentiation:</u>

Yakovlev (1962), highlighting the body representation in two week embryo as being three layered viz. the ectoderm, mesoderm and endoderm, surmises that the vegatative movements have their musculoskeletal origins in the mesoderm and endoderm. The neural control for speech movements are hypothesized to arise from the mantle (nuclear) and marginal (cortical) layers, whereas that subserving the vegetative movements originate primarily in matrix and mantle layers.

Epitomizing, though the two motor acts share common emryonic origin (nasoderm and endoderm of the body and mantle or nuclear layer of the nervous system), they have separate body and nervous system origins in the embryo.

(b) Myelination:

There is a centrifugal growth pattern of myelin (beginning in utero) in the brainstem progressing headward and footward, mostly along a vertical axis (Milner, 1976; Whitaker, 1976). The primary areas of visual, motor, somato-sensory and auditory cortices undergo myelination in this approximate order to complete a vertical hard wiring of the long loop fast acting pathways towards the end of the first year. Secondary areas and association areas myelinate in a horizontal direction as zones around the primary. These are regarded as critical to the eventual development of speech and language and have no known role in the regulation of vegetative movements (Netsell, 1986).

The above hypotheses implicate that the vegetative commend neurons might be inhibited or otherwise silenced during any speech activity, this being achieved via vegetative therapy.

Physiological correlation:

Speech motor function is phylogenetic and ontogenetic differentiation of the more primitive functions of sucking, chewing and swallowing (Header and Muyskens, 1959). "... specific vegetative structures and functions arose through a process of fragmentation of the simpler peristaltic structures and functions. These newer functions form the matrix from which the speech movements emerged. Thus vocal tract movements for vowels and consonants emerged from fragmentation of the peristaltic wave (Shohara, 1932; Header and Muyskens, 1950) with the supportive data derived from x-ray similarities of tongue configuration during vowel productions and segmentation of swallowing act. Hence speech is considered to be 'overlaid' on these vegetative functions. The clinical observations reinforcing this hypotheses include as cited by Netsell, 1986 -

(i) The fact that speech is almost always severely impaired with impairment in deglutition.

(ii) Speech improves with improvement in swallowing,

(iii) Chewing therapy (Froeschla', 1951) with simultaneous chewing and speaking improves speech while on the other hand, attempts to improve speech without chewing are frequently unsuccessful.

Other supportive evidence is derived from studies of sensory afferents by Lund, Appenteng and seguin (1982).

Intraoral receptors: Intraoral mechano-receptore, whether mucosal or periodontal, do not discharge during manually imposed movements of the jaw unless something comes in contact with their receptive field. Consequently, they fire during the jaw closing phase of chewing when intermittently active or silent, eventhough there is a rhythmical activity in the muscles of lips and tongue during mastication. Abbs and Cole (1982) report that contributions of the facial muscles during speech would indirectly generate feedback from skin and mucosa, but the results obtained by Lund, Appenteng and Seguin (1982) suggest that this effect is minimal except during very vigorous movements.

Mucosal and cutaneous activity: Lund et al. (1982) report that hair afferents provide a continuous velocity signal during speech and that the velocity of jaw motion during speech appeared to be comparable to those reported for mastication in man. Netsell (1982) reports of typicalvelocity for speech being 5-15 cm/second and that for chewing gum being 11 cm/second with peak velocity ranging upto 20 cm/second as reported by Mannam, Scott and Decou (1976). In rabbits, hair cell receptors signal jaw velocity upto atleast 30 cm/second (measured at incisors) during closure. Assuming that the receptor activity is similar in man, it is expected that hairs over the lower face signal jaw velocity during both opening and closing movements of speech.

Spindle reflexes: In chewing, the jaw closing motoneurons are hyperpolarized during opening by a central pattern generator (Nakamura and Kubo, 1978; Goldberg and Tal, 1979). The intent is to block the effect of spindle inputs. It is presumed that the program which produces centrally generated rapid closing movements of speech must include postzynaptic inhibition of the jaw closing motoneurons to prevent rebound closure. This implies that spindle afferents are not controlling jaw closing motoneurons during this phase, but they may be used to control jaw opening perhaps via the motor cortex. some motoneurons in the masticatory area of monkey's motor contex discharge prior to jaw opening at frequencies which are proportional to the final position of the jaw (Lund and Lamane, 1974), receiving input from the jaw closing muscle spindles. Itwas suggested that this input could be used to control jaw position during opening. Lund (1982) suggests that a similar cortical mechanism could regulate the tongue and lip contributions to the opening or closing of the oral cavity which are inversely proportional to the amplitude of jaw displacement during repetitions of the same speech goal (Hughes and Abbs, 1976). The situation reverts during jaw closure in biting or chewing with the jaw closing motoneurons being depolarised (Nakamura and Kubo, 1978; Goldberg and Tal, 1979) and therefore, though their firing frequency of spindle afferents may be lower than during the opening, their post - synaptic effects are powerful, which would permit an effective servocontrol of muscle output.

Perioral and jaw opening reflexes: Abbs and Cole (1982) suggest that the perioral reflex is primarily nociceptive and as such has no role in the direct control of speech movements. Yet the movements of mastication and probably speech generate bursts of activity in the same group of receptors which normally trigger the reflex. The reason that these movements are not disrupted by reflexes is that the segmental transmission is modified during movement (Bratzlavsky, 1979). This may be accomplished in jaw by the presynaptic inhibition (Lund, 1982). The noxious or potentially noxious inputs eliciting protective reflex responses appear to be most necessary during biting or jaw closing phase of mastication when tongue or lips can be trapped between the teeth and when presence of hard particles in the food can overload teeth or the periodontal ligament. It appears that these inputs are not filtered during mastication when tongue or lips can be trapped between the teeth and when presence of hard particles in the food can overload teeth or the periodontal ligament. It appears that these inputs are not filtered during mastication nor perhaps during speech (Lund, Appenteng and Seguin, 1982). Instead, the sensitivity of reflex is increased in the closing phase.

These constitute the commonalities and differences between the masticatory and speech physiology.

Psychological correlations:

Eating and conversation belong together with the countless relationships in social sphere (Froeschls, 1951) implying the relationship between the two. Thus chewing,psychologically contains one of the raw material for the development of speech.

Epitomizing, evidences for and against the two divergent view points of relationship/difference between the two stereotypic automated motor acts have been gathered from history, cross-cultural observations, embryological, developmental anatomical and physiological mechanisms involved. These reflect that the vegetative acts may be a phylogenetic/ ontogenetic predecessor of speech, also equally well asserting that speech is not the fractional derivation of swallowing act. Also, the afferent-motor relationships and reflexology of swallow seem to overlap and also have distinct differences. These implicate that in the absence of adequate data, we as speech therapists ought to rely on a conservative blend of theory and practice most apt for the client in question. For instance, in presence of severe dysarthria or anarthria, tackling the antecedent vegetative act of deglutition employing appropriate oroneuromotor vegetative exercises may facilitate speech. Froeschls' chewing technique employed here, as reported by Netsell (1986) may thus facilitate speech not because it is a phylogenetic or ontogenetic predecessor, but because -

(i) It generates afferent consequences of oromotor movements which speech cannot;

(ii) It forces speech motor equivalence during the chewing act or

(iii) The afference generated during chewing engages neuronal connections that are common to both chewing and speech.

The succeding chapter highlights the feeding problems and its relation to articulation in the clinical domain of cerebral palsy emphasizing or refuting the statement that 'speech is an overlaid function'.

II. SPEECH PERFORMANCE AND ITS RELATION TO DEGLUTITION:

Therapeutic curriculum in the management of cerebral palsy has historically included a universal prescription of oroneuromotor training to improve the oropharyngeal functions. These have been incorporated either -

(i) prior to emergence of speech,

(ii) during or

(iii) after speech emergence

Training is geared towards reversal or reduction of dysphagic elements (by instituting feeding programs, handling specifically the first 2 phases of deglutition, vis, the oral and pharyngeal stage) and thereby ameliorating dysarthria. Precise criteria for developing feeding facilitation programs are limited (some of them include that recommended by Shohara, 1932; Palmer, 1947; Mysak, 1960; Gallender, 1979; Scherzer and Tscharnuter, 1982 etc.)Owing to a dirth in systematic research in this area in the cerebral palsied population. The current section reviews this relationship between the 2 stereotypic automated motor acts on the basis of clinical observation and experimentation.

Speech pathologists employing neurodevelopmental therapy, question the extent of influence of abnormal cranio-oropharyngeal reflexes on speech production in cerebral palsied. They opine that infantile oral feeding reflexes, if diminished or absent, may contribute to long standing dysphagia. Abnormal persistence of cranio-oropharyngeal reflexes as seen in neurological conditions, may interfere with speech production (Mysak, 1959, 1963, 1968; Sheppard, 1964).

Ingram (1962) asserts that "Absnormalities of spontaneous feeding are of greatest diagnostic and prognostic significance in neurological disorders of infants. On the other hand, the artificial elicitation of individual feeding reflexes, the rooting, sucking and swallowing responses is less informative". The cases with which these reflexes can be elicited varies greatly even in healthy infants - being more easily elicited when the infant is hungry or drowsy or in a feeding rather than supine posture.

Sheppard (1964) in a study on 51 cerebral palsied (25 athetoids, 24 spastics, 2 rigidities,age range being 2.1 to 26 years with three-fifths between 5-10 years) documented the relationship between infantile cranio-oropharyngeal motor patterns in relation to age, feeding competence, speech intelligibility and speech therapy progress. Results indicated that the patterns were often present in cerebral palsied population in all age groups examined, but were generally less numerous and of longer latency as age increased. Adequacy of speech, speech therapy progress and feeding were found to decrease as the number of patterns shown increased and as the latency of pattern response decreased. This study finds a basis for advocating 2 therapeutic regimes—

(i) Selective facilitation of infantile feeding reflexes to enhance spontaneous feeding behaviour and

(ii) In accordance with the natural sequence, these infantile reflexes after being stimulated and served the vegetative functions, should eventually be suppressed and replaced by higher forms of oroneuromotor activity like speech. This follows the '<u>stimulation-development principle of emergent reflexes</u>(Mysak, 1960) .

Bosma (1975), summarizing the development of oral and pharyngealfunction in normal infants concluded that "... early speech gestures are not directly related to the development of feeding in early infancy and childhood, although speech acquisitions of discriminate coordinations are analogous tomotor discriminations of biting and front of the mouth feeding gestures".

Love, Hagerman and Taimi, (1980) investigated the relationship between speech performance, dysphagia and oral reflexes in 60 severely handicapped cerebral palsied ranging in age from 3 to 26 years. Five feeding skills - biting, sucking, swallowing, chewing of soft and firm food were assessed with criteria for adequacy operationally defined as follows:-

(i) Biting - this consisted of requiring the subject to break completely a piece of Melba toast with movement of the upper and lower jaws within 2 seconds. The task was demonstrated by the examiner to clarify the verbal instructions.

(ii) Sucking was defined as drinking two ounces of kool-Aid from a cup through a plastic straw 8.5 mm in diameter. The angle of the straw and cup to the face was not less than 45^0. Time to straw-drink the liquid was measured to the nearest second, and if the liquid was consumed in one minute, performance was considered as adequate.

(iii) Swallowing was assessed during drinking. Each subject was given a small amount of Kool-Aid to drink from a straw or cup. A swallow was defined in 2 ways following the criteria of tear, Flanagan and Moorees,(1965).

(a) The examiner observed the skin over the larynx for the characteristic upward and downward movement frequently obvious in deglutition.

(b) Simultaneous to this observation, the examiner listened for the "short sharp noise which can invariably be detectable with a stethoscope on the skin, lateral to the laryngeal prominence" (Lear, Flanagan and Moorees, 1965).

If the movement was observed, or a swallow sound heard within two seconds after the liquid was drunk, swallow was judged as adequate. Presence of drooling was also noted in connection with swallowing behaviour.

(iv) Chewing of soft food was tested by placing a miniature marshmallow in the subject's mouth. After 3-4 strekes of the mandible, the subject was asked to open his mouth and if the marshmallow was lacerated within 15 seconds, the skill was judged as adequate.

(v) Chewing of firm food was assessed by requesting the subject to chew a piece of uncooked carrot. After 5-6 strokes of the mandible, the examiner noted if the carrot was broken into several pieces. If it was pulverized within 30 seconds, the skill was judged as adequate.

Primitive oral reflexes assessed included those affecting oral and pharyngeal areas (Sheppard, 1964). The effect of ATNR and Moro reflex on infantile oral reflexes was also studied. There was a trend for subjects with more adequate feeding skills to achieve higher levels of overall speech proficiency and articulatory competency though not completely systematic. ATNR and MORO seemed to have limited affect. In general, the results supported the universal prescription of feeding management in C.P. but modification of abnormal oropharyngeal reflexes received less support. They report that "several oromotor training techniques available to speech-language pathologists may be disappointing in all but the milder cases of motor involvement of oral musculature". The presence and number of dysphagic symptoms did not precisely predict the lack of speech. Hence lack of speech may be associated with cognitive and other oro-sensory motor deficits.

Russell (1984) reports that improvement in multiply handicapped children and adults often haying functional problems concerning eating and speech either due to anatomical and neurological deficit can be demonstrated by stimulation or resistance exercises for the weak and uncoordinated perioral muscles.

Hardy (1983)opines that severity of dysphagia is not reflective of severity of dysarthria. Reportedly, "... assessing a speaker's ability to perform nonspeech movements or so called movements on the voluntary level, has limited usefulness..... assessing functions of the oral structures at the so called vegetative level may have even more limited utilization. As a consequence, I am disinclined to use observation of the chewing and deglutition behaviours as a routine part of the assessment process. The fact that a child with cerebral palsy has difficulty chewing, managing the bolus of food in the mouth and swallowing usually will be confirmatory of a neuromotor problem involving the oral structures, and such observations may be helpful in selecting instances in the clinical process. However, the idea that the severity of chewing and swallowing difficulties reflect the severity of speech physiology problems in the individual cases may be very misleading."

Mavinakere (1984); Mavinakere and Sivanan than (1986); suggested that feeding could be analysed as a skill by itself in terms of ingestion, retention, communication and transportation and deglutition. Development of these skills are stimulated and sustained by extraneous variables like gravity, positioning and orientation. It was hypothesized that the feeding problems encountered in cerebral palsy could be accommodative reactions evolved to enable them feed despite their inability to cope up with these extraneous factors. This was put-forth on the basis of their study on 3 normal adults, aged 28-35 years with no occlusal problems. The subjects were required to chew 10 half pieces of roasted peanuts in the following 3 conditions imposing different retention demands.

(i) Chewing normally.

(ii) Chewing with lower lip restrained

(iii) Chewing with lower lip and movement of the head restrained.

and analyzing the particle break down in percentage after passing the chewed material through sieves of different apertures. Here no attempt was made to relate feeding to speech skills.

The other related areas include relationship between tongue thrust, articulation and deglutition. Weinberg (1970), in a review of literature on tongue thrust reports of the following it three chief oral behaviours accompanying it -

i) Active or excessive contraction of the circumoral musculature.

ii) Absence of molar contact with associated diminition or absence of palpable contraction of the muscles of mastication, and

iii) Protrusion of the tongue between or beyond the incisors during swallow (Fletcher, et al. 1961; Straub, 1960).

Here, an attempt has been made to relate speech with infantile swallowing behaviour of tongue thrust in normals and thence to provide a basis for evaluation of this behaviour in cerebral palsied wherein it may form a component of the generalized extensor thrust.

Fletcher, Casteel and Bradley (1961) in an attempt to estimate the magnitude of tongue thrust swallowing pattern and of associated speech distortions reported that in a total of 1615 children, with age ranging from 6-18 years, the incidence of tongue thrust swallow was 668, that of sibilant distortion was 230 and that of simultaneous visceral swallow and sibilant distortion was 181. Also incidence of visceral swallow numerically decreased with increase in age.

Barrett (1961) reported of persistent lateral lispers to be tongue thrusters. The sibilant distortion especially in /s/ appeared to approach the sound of a lisp, but was only minimally observable, though clearly identifi able as an articulatory deficit.

On the contrary, other researchers Fymbo (1936); Palmer (1948); Fairbanks and Lintner, Mary, (1951); Whitman and Jann (1951); Hanley and Supemaw (1956); Bloomer (1957); Bennett (1958); Francis (1958, 1960); Larr (1962); Mendel (1962); Werlich (1962) support the hypothesis that speech differences may result from lingual habit differences.

Ward (1961) also studied the relationship between occlusion, speech articulation and swallow patterns in 358 children from grade one through three and reported that many children with malocclusion and tongue thrust did not make articulatory errors. Neither visceral swallow nor articulatory error rate decreased with age. Remarkably, she reported an increase in articulation error for 7 of the 8 test sounds as a function of age increase. For /l/, there was an increase of 22% in errors from first to third grade.

Subtelny, Mestre and Subtelny (1964) in a study on occlusion, clinical appraisal of patterns of deglutition and cephalometric roentgenographic study on speech articulation on 3 groups of subjects.- -

(i) 30 adolescents with normal occlusion and normal speech,

(ii) 31 adolescents with severe class II division I malocclusion and normal speech, and

(iii) 20 subjects with severe class II division I malocclusion and defective speech (lisping)

reported that subjects with class II division I malocclusion and tongue thrust during swallow were more likely to have an associated lisp than subjects with the same type of malocclusion who did not have tongue thrust swallow. However, the proportion of subjects with lisping was not significantly higher in the sample with tongue thrust. Moreover, 17% of their total sample with malocclusion and tongue thrust had normal speech. Similarly, 17% with malocclusion had defective speech but did not thrust the tongue during swallow.

The current data implicates cautions interpretation of the strength of the observed relationships between occlusion, tongue thrust swallow and lisping. Given the current state of art, a question that meritis future discussion is whether the definition, clinical diagnosis and management of swallow performance per se falls within the competence, responsibility or province of the speech pathology,a profession whose prime commitment is the diagnosis and treatment of communication disorders. Catering to the needs of the cerebral palsied population, this is of greater value owing to tongue thrust being a component of the generalized extensor thrust.

Epilogue:

Tongue and bulbar exercises via feeding therapy attempt to utilize the elements of oral movements accompanying eating and drinking to elicit sound production or speech pMrequisits. The results of these studies tend to confirm the zemidependency of speech and deglutition and thence the value of widespread prescription of feeding therapy in amelioration of dysphagic and dysarthric elements despite the striking finding that dysphagic symptoms do not necessarily predict the presence or likelihood of dysarthria. This highlights the need to enlist the deviancies/deficiencies found in the first two phases of deglutition - the oral and pharyngeal phases which are within our province so as to have a finesse for our therapeutic regime. The forthcoming chapters deal with the issues on normal aspects of deglutition and the expected deviances in cerebral palsied.

III. DEGLUTITION:

"Deglutition is the process whereby a bolus, liquid or solid is transferred from the buccal cavity to the stomach"(Lund, 1987). This complex, continuous act integrates motor performance from several cranial somatic systems and coordinates autonomic system within the esophagus and stomach. It directly incorporates the aspects of tone, posture and reflex behaviours of head and oral mechanism. (Scherzer and Tscharnuter, 1982). A vital function in sustaining life, deglutition aids in -

(i) transporting food to stomach, hence being significant for nutrition.

(ii) the subsidiary functions include disposal of dust and bacteria laden mucus conveyed by ciliary action to the pharynx from nasal passages and sinuses, tympanic cavities, larynx and tracheobronchial tree;

(iii) the opening of the pharyngeal ostia or the pharyngo-tympanic tubes accompanying deglutition serves in pressure equalization of the middle ear cavity (Jones, 1979).

Assessment of deglutition historically has incorporated various techniques including direct observation, cineradiographic studies (Saunders, Davis and Miller, 1951; Ardran and Kemp,1955; Sloan, Brummett and Westover, 1964; Cleall, 1965; Moll, 1965).

Combined pressure and radiographic studies (Atkinson et al. 1957; Sokol et al. 1966); videoflurographic technique (Logemann, 1986)etc. These have aided in delineating the 3 stages of deglutition (Magendie, 1816; Weinberg, 1970, Jones, 1979, Lund, 1987) on the basis of the anatomical landmark through which they pass.

(1) The oral stage - oral preparatory stage

- bolus penetration from mouth to pharynx.

(ii) Pharyngeal stage

(iii) Esophageal stage.

The first two phases interact with other functions of respiration, speech, suckle etc, in which circumstances, swallow predominates. This section deals with only the first two phases of deglutition at length which is of current interest for this study.

Oral preparatory phase:

The oral preparatory motions occuring prior to reflex deglutition include -

i) Buccal actions to enclose food.

ii) Biting

iii) Mastication with admixture of saliva.

iv) Tongue maneuvers that effect the necessary intraoral manipulation of food

v) Moderate hyoid elevation to swallow-preparatory position.

vi) Arrest of oral manipulation of food, respiration and cervical posture motions associated with this movement of hyoid (Shelton, Bosma and Sheets, 1960).

vii) Bolus positioning on centre of tongue.

viii) Tongue elevation and depression of soft palate preventing bolus from penetrating pharyngeal airway (Bosma,1957).

Buccal action to enclose food:

As cited by Guyton (1986); Lund (1987) and others,the lips are used in the transfer of fluid and solid food into the mouth and to retain the food in the oral cavity during mastication. The lips and cheeks assist the tongue in ensuring the replacement of food between the teeth during chewing. Their high neural sensitivity, both thermal and tactile help in the entry of food into the mouth and preventing the cheeks from coming between the teeth during masticatory strokes. Ossationally some food may be held in the oral vestibule between the cheeks and the alveolar ridge and teeth, called the parking bolus (Jones, 1979). Normally, as the food is placed in the mouth, the lips close and remain closed during all phases of swallow to keep the food in the mouth anteriorly (Logemann, 1986).

Drinking patterns:

Sucking - This action proceeding the primitive sucking process, commences when the child is mature enough to be started on strained foods. A discontinuous process unlike sucking, this requires coordinated effort involving the rhythmical pumping and squirting action of the tongue, mandible and soft palate musculature.

The following actions characterize the sucking process (Gallender, 1979):

(i) The mandible is flexible. In sucking, it is lowered slightly.

(ii) The anterior half of the tongue depresses by pulling away from the hard palate.

(iii) The tongue is grooved longitudinally by the intrinsic superior longitudinal muscle fibers and the anterior half of the genioglossus muscle. This groove provides the space for the teat or nipple.

(iv) The lips are placed around the nipple forming a seal. This prevents air from being pulled into the mouth instead of the liquid when the negative pressure is achieved.

(v) The masseter muscles contract elevating the lower jaw, positioning it for appropriate lip and tongue action.

(vi) The anterior margins and the lateral borders of the tongue curl up surrounding and compressing the teat against the upper gum pad.

(vii) The posterior section of the tongue rises up making contact with the depressed soft palate. This action seals off the nasopharyngeal passageway from the oral cavity and prevents air from being pulled in through the nose.

(viii) There is a furrowing or grooving of the tongue which serves as a food tract. This central furrow in the tongue is assisted by the wavelike contraction in the fibers of the transverse muscles.

(ix) The food is in a state ready to be swallowed. The bolus is formed. There is a slight pause in the breathing cycle. The swallowing pattern is initiated by the bolus being forced into the pharynx.

(x) The contrictor muscles of the pharynx forces the bolus pass the lazynx and into the esophagus.

CMP drinking: The normal infant initiates cup drinking by the age of 5-6 months (Scherzer and Tscharnuter, 1982). He has the ability to start taking sips from the glass at approximately 8-10 months of age. By the age of 12-14 months, the child can usually drink from a glass with some assistance.

This signifies the development of lip control, tongue coordination and jaw closure playing important role in drinking without much spillage or assistance (Gallender, 1979). The normal stages of development is marked by retention of the primitive sucking movement (especially when drinking from a pouted cup) leading directly to drinking from a glass (Gallender, 1979).

Spoon feeding: Two to three spoon fulls of solids is introduced by the age of 3 months, which is shortly after the infant learns to swallow voluntarily. At 5-6 months of age, solids, constitute a substantial part of the child's diet. The switch from sucking to effective handling of solids is gradual, with initial attempts at spoon feeding being unsuccessful owing to the persistence of sucking motion (Scherzer and Tschamuter, 1982).

Mastication:

The complex neuromuscular activities of mastication involve mechanic*!, chemical and enzymatic processes employing lips, teeth, cheeks, tongue, palate and other oral structures to prepare food for swallowing (Kawamura, 1964; Pritchard, 1965). Murphy (1965) has described the masticatory stroke in 6 phases:

(i) The preparatory phase, in which the food is ingested and positioned by the tongue within the oral cavity, and the mandible is moved towards the chewing side. There is a slight, constant deviation to the nonfood side an instant before the masticatory stroke begins and this point is identified as the 'precise beginning' of the preparatory phase.

(ii) Food contact, characterized by a momentary hesitation in movement, interpreted to be a pause triggered by sensory receptors concerning the apparent viscosity of the food and probable transarticular pressures incident to chewing. This is mainly a result of inhibition of the resting tone of the jaw closing muscles and active contraction of jaw opening muscles. This masticatory reflex is unilateral (Jones, 1979).

(iii) The crushing phase, which starts with high velocity then slows as the food is crushed and 'packed'. Gibbs (1969) observed that when the central incisor is approximately 0.24 inch from closure, the jaw motion is stabilized at the condyl on the working side and the final closing stroke thereafter is guided by this 'braced condyle'. Ahlgren (1961), reported that the first three or four strokes in mastication typically emphasize the crushing phase and that they usually display equal and synchronous activity on both sides.

(iv) Tooth contact, accompanied by a slight change in direction but no delay. Murphy (1965) reports that all reflex adjustments of the musculature for tooth contact are completed in the crushing phase before actual contact is made. Moller (1966), supporting this observation, demonstrated decreases in electromyographically recorded activity of the mandibular elevator muscles before molar contact. Conversely, Beaudreau, Daugherty and Marland (1969), report a 'distinct and discrete motor pause' consistently elicited in the temporalis and masseter following tooth contact.

(v) Grinding phase - This coincides with transgression of the mandibular molars across their maxillary counterparts and is therefore highly constant from cycle to cycle. This phase was termed the terminal functional orbit (Messerman, 1963). Ahlgren (1961) noted that during this phase the bilateral muscular discharge becomes unequal and asynchronous, indicating that the person is chewing unilaterally.

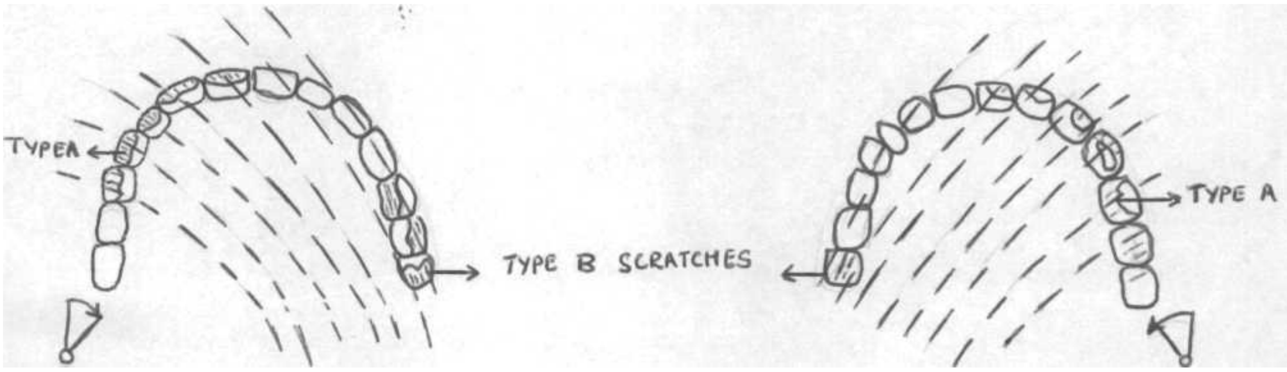
(vi) Centric occlusion, when movement of the teeth comes to a definite and distinct stop at a single terminal point from which the preparatory phase of the next stroke begins. Gibbs (1969), reported that the jaw of subjects with normal occlusion remained in this position for a 'considerable time' whereas the pause was rather brief for those with malocclusion. Dynamic occlusion (i,e, the manner in which the lower dental arch traverse the upper one in mastication) and its relation to masticatory movements as in denture wearer was studied by Murphy (l963). His observations indicate that right and left masticatory strokes have their own axis of movement behind and lateral to the arch on the opposite side. There is no position common to both dynamic and centric occlusion so long as the movement continues along the axis, but every masticatory stroke, whether right or left side, ends in the position of centric occlusion. On this basis, two attritional facets on each side of the dental arch have been demonstrated.

Type A facets where each scratch mark on the worn enamel surface lies on the circumference of a circle whose centre is behind the arch on the same side;

Type B facets - where each scratch mark lies on the circumference of a circle whose centre is behind the arch on the opposite side.

Axis of masticatory movement and method of determination (Murphy, 1966):

Constructing artificial teeth and studying the dynamic occlusion aids in determination of the masticatory stroke. When the food bolus is on the right side, the natural lower teeth from the median plane to the right second premolar traverse the corresponding parts of the upper denture and at the same time grind any interposed food particles. The movement is in general terms across the bucco-lingual axis of the teeth and so the resulting surface scratches fit the type A definition.



Bolus on right side   Bolus on left side

Fig.l: Type A and B scratches in relation to bolus position (Murphy, 1966).

At the same time on the side opposite the food bolus, the natural lower second premolar and mesio-buccal cusp of the first molar traverse the most mesial of the three type B areas, the remaining buccal cusps of the first molar traverse the intermediate type B area, and the mesial cusps and disto-buccal cusp of the second molar traverse the most distal type

B area. There are no interposed food particles. The movement on this side is along the mesio-distal axis of the teeth and so, the resulting scratches fit the type B definition.

When the bolus is on the left side, the mechanism is almost a mirror image of the one described above for the right. On the food side, however, the type A area extends more distally to include the first molar and the mesial part of the second molar. On the nonfood side, there is only one type B area which is attritioned by the natural lower third molar tooth (Fig.l).

Area of occlusal contact: The masticatory surfaces of the teeth do not necessarily make contacts with each chewing movement. Murphy (1956) studied tooth contact with simultaneous electromyographic records. The percentage of masticatory strokes in which tooth surfaces came into actual contact varied with the physical nature of the masticated food. For instance, in chewing meat or bread, 50% of the chewing strokes were completed by booth contact while in chewing biscuits contact took place very seldom. Murphy's (1966) study on attritioned dentition with segregation of the 2 zones with A and B scratches raises the question of the mechanism involved, indicating some factor disengaging the distal zone on the food side (to allone escape of contact) and the mesial zone on the nonfood side.

Disengagement onthe food side: An initial retrusion of the condyle on the food side was noted by Chick (1952), Pruzansky (1952); Perry and Harris (l954); Tulley (1959); Lammie et al. (1959). The effect of this movement of the condyl on the food side is to bring it into the posterior district of the joint (Murphy, 1965). This position is distal to the neutral position between the joint districts which is normally coincidental with centric occlusion (Fig.2). A result of this movement is a disengagement of the distal zone of the lower dental arch from that of the upper on the food side in the masticatory stroke, thus allowing it to escape contact.

Disengagement on the nonfood side: When the condyl on the nonfood side is carried forwards in the depression and deviation movement at the beginning of the masticatory stroke, it is lowered on the articular tubercle. This also lowers the mandibular arch on the nonfood side and hence the whole mandible is tilted. This tilt appears to be a logical mechanism to disengage the mesial area of the lower arch from that of the upper on the nonfood side in the masticatory stroke, thus allowing it to escape contact (Fig.3), Murphy (1966).

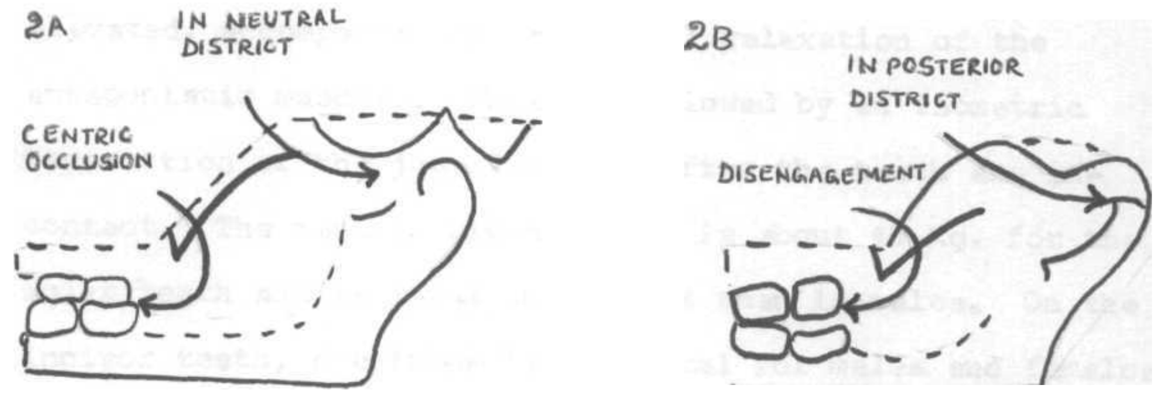


Fig.2: Disengagement of distal area on food side postulated mechanism (Murphy, 1966).

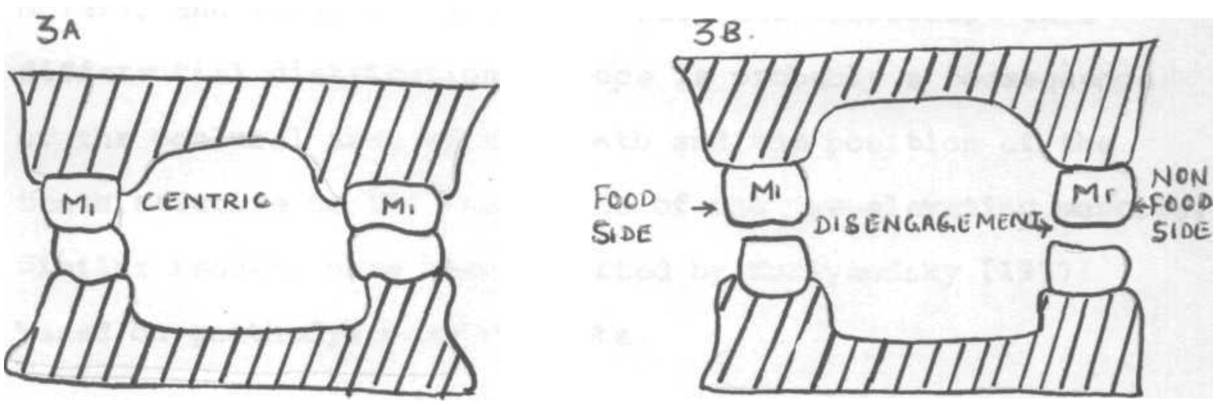


Fig.3: Disengagement of mesial area on nonfood side-postulated mechanism (Murphy, 1966).

Masticatory force : This comprises initially an isotonic contraction of the jaw closing muscles as the lower jaw is elevated, accompanied by reciprocal relaxation of the antagonistic muscles. This is followed by an isometric contraction of the jaw elevators after the teeth are in-contact. The maximum biting force is about 45 Kg. for the molar teeth and is lower in females than in males. On the incisor teeth, the force is identical for males and females. In normal chewing of food, the masticatory force applied to the teeth is about one-third of the maximum. The force varies in different parts of the dental arch. It is greatest at the first molars, slightly less on the second and third molars, and lower still at premolars and incisors. This differential distribution of foce is probably a consequence of the occlusal area of the teeth and the position of the teeth relative to the insertions of the jaw-elevating muscles. Similar results have been reported by Kurlyandsky (1977) based on gnathodynamometric data.

Effort exerted for grinding various foods: Studies pertinent to effort exerted in grinding different food materials is of practical interest for clinicians handling eating handicaps. This force can be measured with phagodynamometer or with a myotonodynamograph.(Table 1)

Table-1: Influence of food particle size and location and tooth shape on initial grinding force (Kzrlyandsky, 1977).

Type of food	Teeth	Initial grinding force, kg.							
		6543	654	54	21	12	123	123	Note
		6543	654	54	21	12	123	123	
Rye bread fresh		12	10.6	-	-			0.9	Compressed but not broken into Parts
Rye bread crust		100.6	100.6					60.0	
Rusks		16.6	14.6	10.6	12.6				
Rusks, childrens		14.6	10.6	6.6	8.6				
Carrots fresh		16.6	14.6	6.6	10.6				
Lump sugar		28.6	16.6	10.6					
Almond kerrel		10.6	4.6	4.6	4.6				

Analysis of this table reveals the following:

(i) The maximum force required for breakdown of the hardest and pastiest food (bread crust) is 100.6Kg. The muscles of mastication cannot exert such force of masticatory pressure because the periodontium is not adapted to such a load. Hence importance is attached to the effect of saliva and other fluids which alter the physical properties of the food. The effort needed for ginding pasty food 4s also reduced by means of external appliance (eg. tearing with hand).

(ii) The strongest force (though rarely applied) needed at the first moment of food grinding under conditions excluding the mechanical effect of fluids and hand aid (cracking of a nutshell) can be assumed to be 26.6 Kg.

(iii) Foodstuffs prevailing in the diet of humans including cooked and fried meat, rusks, vegetable, fresh bread etc. require a maximum force of 18 to 20 Kg at the onset of grinding. The force is considerably reduced when the food is exposed to the effect of saliva and any other fluid.

(iv) The forces needed at the first moment of food grinding vary directly with the shape of the teeth. Less effort is exerted when the food is broken by incisors. For instance, a pressure of 12.6 Kg is required for grinding the soft part of bread with the masticating teeth, and a pressure of 900 grams for grinding it with the incisors; the masticating teeth exert a pressure of 100.6 kg. and the incisors a pressure of 60 kg. for breaking up a bread crust? the pressure applied for grinding carrots, almond kernel, and rusks are respectively 16.6 and 10.6 kg, 10.6 and 4.6 kg and 14.6 and 8.6 kg.

(v) The smaller the particle of food, the less force is needed at the onset of grinding.

Assessment of masticatory process: Grossly dichotomizing, two methods of establishing the degree of masticatory efficiency have been suggested.

(i) The static method, and

(ii) The functional method.

(i) Static method - This is based on the premise that functional importance of each tooth could be indicated by conventional symbols (coefficient), the sum of which would show the total functional ability of the maxillodental system. With loss of some teeth, the degree of impairment of the masticatory apparatus could be determined by subtracting the sum of their coefficients. The tests commonly used are: the size of the cutting or masticatory surface, the thickness and length of roots, number of roots, number of cusps, distance from the tooth to the site of attachment of the main muscles of mastication (influence of the lever arm length) etc. (cited by Kurlyandsky, 1977)

(ii) The functional methods- The static method is of a relative character because of the lack of allowance for adaptation of humans to mastication following loss of teeth. This factor can be determined by the functional mastication tests aiding in estimating more or less correctly the actual functional state of the dentil system. Kurlyandsky (1977) lists out the available tests of mastication.

(i) The first attempt to give an objective evaluation of the functional state of the maxillo dental system was made by Christiansen who proposed a test of masticating ability by giving the subject food of a definite weight and consistency and then examining how well it was chewed (subjective analysis).

(ii) Gelman's test of mastication: The subject takes a 5 gram portion of almonds and begins to chew at the signal 'begin please'. The beginning of mastication is noted on a stopwatch. 50 seconds later, the signal 'stop' is given, the subject ceases chewing, spits out the chewed mass into a porcelain dish, and rinses his mouth, spitting the water into the same dish. For disinfection, 5-10 drops of 5% mercuric chloride solution are added to the dish. Then the contents are strained through gauze and the remains left on it are dried on a water bath and then sifted through a sieve. The sifting ought to be done thoroughly, stirring the mass frequently, preferably with a wooden stick so that all particles capable of passing through the meshes should escape. The mass left on the sieve is carefully poured into * watch glass of a respective size and Weighed. The weight obtained is converted to percent of the entire standard mass (5 grams)thereby obtaining the percent of mastication impairment. Similar lines were adopted by Lucas and Luke (1983), and employed in the study on feeding problems in cerebral palsy by Mavinakere and sivana than (1986).

The coefficient of masticating efficiency is found by subtracting the percent of mastication impairment from unity. To simplify the calculations, unity is taken for 100% and the percent of mastication impairment is subtracted from it.

(iii) Rubinov's test of mastication - Rubinoo modified the test of mastication approximating it to normal natural stimulation, suggesting that foodstuffs (like nuts, crusts, fresh bread) and their treatment in the oral cavity should be combined with reflexes arising in the oral cavity determined by means of masticatiography. Rubinov reported that with a more impaired dental system, the time needed for chewing hard food (nut) before it was swallowed increased, but nonetheless food particles swallowed were relatively large. The time needed for chewing soft food with intact dentition slightly differed from that with impaired dental system, stressing the importance of external adaptations of the human being to loss of teeth.

The test employs use of a single nut kernel. Gelman's and Rubinov's techniques are used not only to determine the functional condition of the maxillodental system and to apply dental prostheses for facilitative gastrointestinal activity, but also to estimate the efficacy of orthopaedic treatment, prosthetic management etc.

(iv) Love et al (l980) tests for biting and chewing:

a) Biting - This requires the subject to break completely a piece of Melba toast with movement of the upper and lower jaws within two seconds. The task is demonstrated by the examiner to clarify the verbal instructions.

b) Chewing of soft food is tested by placing a miniature marshmallow in the subject mouth. After 3-4 strokes of the mandible, the subject is required to open his mouth and if the marshmallow is lacerated within 15 seconds, the skill is judged as adequate.

c) Chewing of form food is assessed by requesting the subject to chew a piece of uncooked carrot. After 5 or 6 strokes of the mandible, the examiner note if the carrot is broken into several pieces. If the carrot is pulverized within 30 seconds, the skill is judged as adequate.

(v) Vitali (1986), in his Test of Oral Structures and Functions (TOSF) with a section on evaluation of mastication and swallowing recommends the following: Ask the subject to chew then swallow a cracker, cookie or similar piece of dry food. Only one cycle of chewing and swollowing is necessary. The task may be repeated if necessary and is untimed. Note the ease, mobility and integrity of the seal, mastication, bolus manipulation, transport and swallowing of food. The task is untimed. The scoring is as follows:-

a) Unremarkable (O): Examinee's lip seal, mastication, bolus manipulation and swallowing are essentially normal. There is an absence of tongue thrusting, drooling, aspiration, coughing, assistive head tilt, abnormal or restrictive mandibular movement, incoordination and pain or discomfort.

b) Minimal difficult (1): The examinee presents inconsistent and/or minimal abnormality with lip seal, mastication, bolus manipulation or swallowing.

c) Marked difficult (2): The examinee presents essentially consistent dysfunction or a marked difficulty with lip seal, mastication, bolus manipulation or shallowing. Tongue thrusting, drooling, aspiration, coughing, assistive head tilts, abnormal or restrictive mansibular movement, incoordination and pain or discomfort is present.

Swallowing:

Theories on swallowing: Information pertinent to the process of deglutition has increased both in scope and precision through the introduction of instrumentation in the assessment of these oral physiologies. From the currently available information, four theories have been used to describe this behaviour (Wildman, Fletcher and Cox, 1964) including -

(i) The theory of constant propulsion

(ii) Theory of oral expulsion

(iii) Theory of negative pressure

(iv) Theory of integral function.

(i) Theory of constant propulsion - Proponent of this theory was Magendie (1816). Based on anatomical and animal experimental studies deglutition was defined in oral, pharyngeal and esophageal stages, the bolus being forced through these three stages by relatively independent, consecutive muscle propulsion forces.

(ii) Theory of oral expulsion - Thiswas evolved from the work of kronecker and Melzer (1883) in a series of experiments conducted on themselves and dogs, to establish time relationships during various parts of the swallowing act. They observed that the time lapse from the onset of swallowing until: the bolus reached the cardiac sphincter of the esophagus approximated only 0.1 sec. They concluded that the bolus must be ejected directly from the oral cavity to the sphincter into the stomach by a piston like action of the tongue and mylohyoid muscles. However unefluorographic observations offer no support to this theory.

(iii) Theory of negative pressure: Proposed by Barelay (1930) from fluoroscopic observations of the swallowing act, he observed a 'moment of radiolucency' in the pharynx when all existing orifices appeared to be closed. He also noted laryngopharyngeal and esophageal elevation and dilation so that the bolus could be 'popped in' as it exited from the oral cavity and upper pharynx. This brought on to the conclusion that a forward motion of the tongue and a dropping of the larynx creates a negative pressure at the initiation of swallowing which literally sucks the food as far down as the middle of the esophagus before further muscular action is needed for its propulsion. This theory was refuted by Saunders, Davis and Miller (1951); Aitkinson et al (1956). The latter used small pressure sensing transducers in the pharynx during swallowing and found double peaked, positive air pressure fluctuations.

(iv) Theory of integral function - Theorized by Wildman, Fletcher and Cox (1964); this emphasizes the highly integrated, synergestic coordination of the total dynamic processes of swallowing.

The process of swallowing is discussed below following the lines of Magendie's (1816) theory in 3 stages, however stressing the fundamental unity of the act. This includes the - (i) voluntary (ii) involuntary stage.

(i) The preparatory swallow: - This phase commences immediately after liquid is taken into the oral cavity or post mastication of solid food.

Solids:

(a) This phase is signalled by the collection of food and formation of a compact bolus which is moved to a characteristic swallow - preparatory position on the dorsal surface of the tongue (Fletcher, 1970; Gallender, 1979; Jones, 1979; Guyton, 1986). In infants, a second site of bolus accumulation is the valleculae between base of the tongue and epiglottis (Bosma 1957).

(b) Movements of the bolus into the swallow preparatory position is proceeded by - Masseter contraction, bringing the teeth in occlusion.

- establishment of a complete peripheral seal around the bolus by the lips and the teeth or tongue anteriorly; the tongue and palate posteriorly; the palate superiorly; and the tongue buccal teeth and adjacent mucosae laterally.

Liquids: This is drawn into the oral cavity by creating a subatmospheric pressure in the mouth by retraction of tongue

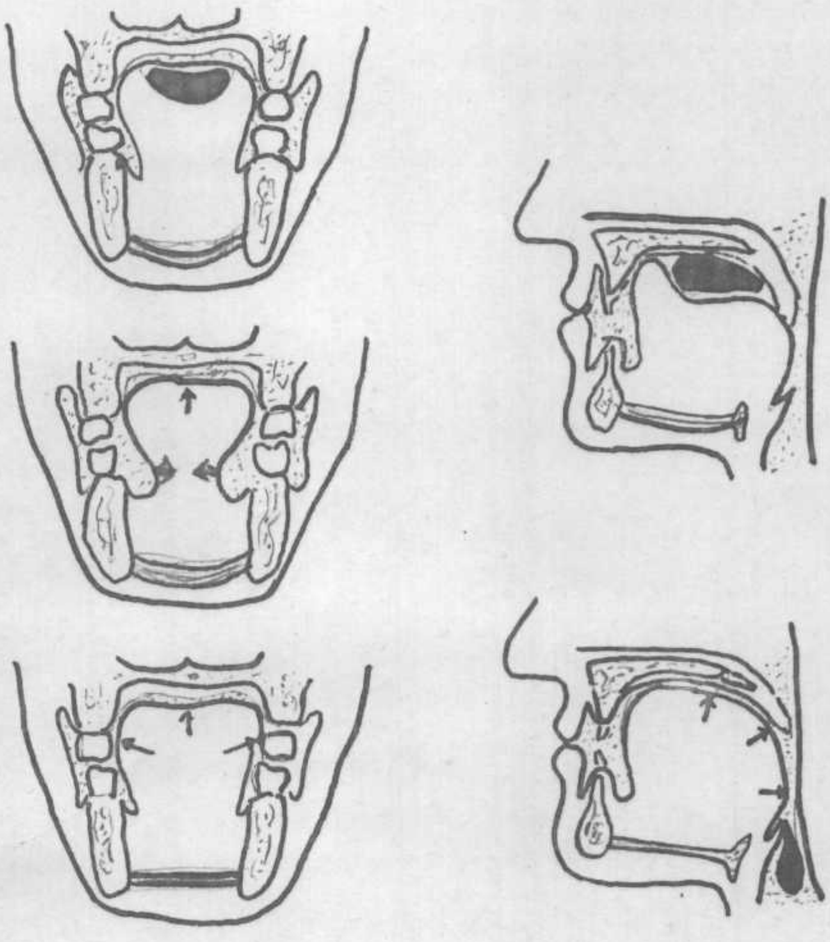


Fig.4 Oral face of swallowing (after Mhillis, 1946)

in contact with the palate. Positioning of liquid on tongue dorsum prior to transporting it into the swallow preparatory position may be facilitated by moving the tongue posteriorly within the sealed oral cavity (Fletcher, 1970). The average volume of water consumed per swallow by adults and children was measured by Jones and Work (1961). They reported an average of 21.3 cc per swallow by men, 13.6 cc per swallow by women, and 4.6 cc per swallow by 1 1/4 - 3 1/2 year old children. They observed a relatively constant 0.27 cc per kilogram ratio between the volume of the swallow and body weight.

Oral phase of swallowing - This phase is initiated slightly prior to the completion of preparatory positioning of the bolus with masseter contraction.

a) It is introduced by elevation of the palate from its tensor veli palatini depressed position against the pharyngeal surface of the tongue (Fletcher, 1958) and contraction of buccinator muscle.
b) By a posterior movement of the tongue root and simultaneous vertical elevation of the hyoid bone and larynx (Shelton et al. 1960).
c) Slight elevation of the hyoid during the previous swallow - preparatory positioning was also noted by Ardran and Kemp (1964).
d) The hyoid movements reported include an even circular hyoid movement to irregular motion with crossing paths

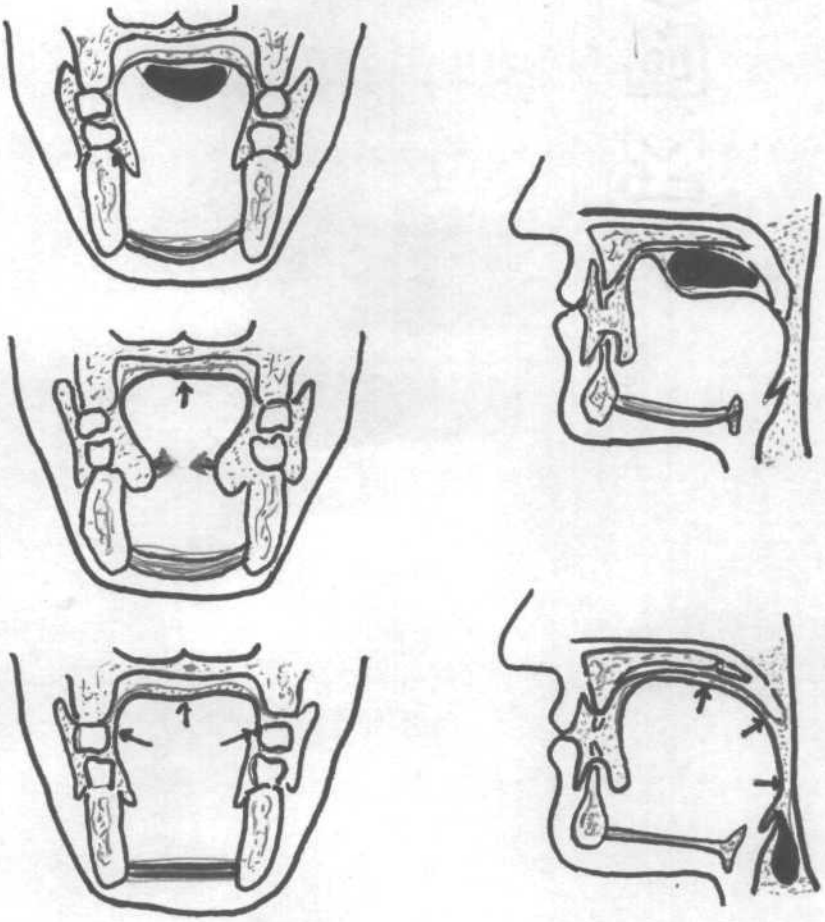


Fig.   Oral face of swallowing (after Wcillis, 1946) of movement as reported by Ingervall, Bratt and Carlsson (1971) in a cineradiographic study on 11 females aged 19-31. Anterior movement is reportedly the typical pattern (Shelton, Bosma and Sheets, 1960). Oblique upward and forward movement has also been noted to occur. Ramsay et al (1955) reports of oblique upward and forward pattern in swallowing large bolus. Gallender (1979) reports of 3 distinct stages of movement of the hyoid bone in mature swallow pattern:

In the first stage, the hyoid bone rises up in conjunction with the elevation of the larynx. This is usually accompanied by a backward and downward movement of the pharyngeal section of the tongue. This movement occurs early in the swallowing pattern as the bolus begins its descent.

- In the second stage, there is an anterior movement of the hyoid bone. This action occurs as the bolus passes through the pharynx and before it enters the mouth of the esophagus.

- In the third stage, the hyoid bone descends posteriorly and inferiorly in a movement parallel to the larynx. This downward movement provides for the reopening of the larynx. In conjunction with this action, the pharyngeal section of the tongue moves back to the position it held prior to the initiation of the swallowing process.

e) Fine coordination between respiration and deglutition is evidenced by a short respiratory pause which commences in this phase of swallowing and extends to the esophageal phase (Kawasaki and Ogura, 1968).

f) With the breaking of the posterior seal, the bolus is moved posteriorly by a progressive anterior - to - posterior rippling contact of the tongue dorsum against the hard palate in the case of solids termed "the stripping wave" (Ramsay et al. 1955), forming the final clearance activity. In the case of fluids, the tongue movements have been analysed in 2 phases (Whillis, 1946). In the first phase with the mouth closed, the contraction of the extrinsic muscles of the tongue brings the tip of the tongue against the palate just behind the incisive papilla. The upper surface of the tongue is moulded to form a longitudinal groove completing with the hard palate, a tubular space containing the fluid. The margins of the tongue are pressed against the lingual surface of the gums and teeth. This moulding of the tongue is due to the contraction of the superior longitudinal and genioglosses muscles. The dorsum of the tongue is next forced upwards. This commences at the anterior end and extends backwards. The movement is brought about by the contraction of inferior part of the transverse lingual muscles and results in a progressive obliteration of the tubular space between the tongue and palate, the effect being squirting of the fluid into the oropharynx. In the second phase, the teeth are brought into occlusion and the mylohyoid muscles contract, raising the floor of the mouth. Consequently, the posterior part of the tongue is forced backwards into the pharynx, pushing the fluid into laryngopharynx.

Note: In the swallowing of solids, this second phase alone isresponsible for thrusting the bolus from the mouth into the pharynx (Whillis, 1946).

g) When a large bolus is to be swallowed, the tongue and the hyoid bone must be pulled well forward to provide adequate accommodation for the bolus to be taken into and through the pharynx; thus maximum displacement of the hyoid forward relates to the degree of distention of the oropharynx. Also, the whole of a mouthful may not be swallowed as a single bolus, but instead of a series of boli. Referred to as piecemeal swallowing, the subject releases a quantity of the content into the pharynx by parting the tongue and soft palate and then raising the tongue in the back of the mouth behind the junction of the hard of soft palate, thus cutting off the bolus in the pharynx from the rest of the content of the mouth proper. The contents of the pharynx are cleared by opposition of the constriction to the back of the tongue and soft palate in the usual manner. In these circumstances, there is no oral phase of swallowing until the last mouthful is expelled (Lund, 1987? Ardran and Kemp 1955; Gallender, 1979? Jones, 1979).

Oral transit time - It is defined as the time taken from the initiation of the tongue movement begin the voluntary oral stage of the swallow until the swallowing reflex is triggered at the anterior faucial arch (Miller, 1982, Pommerenke, 1928) Normally, this time is a maximum of one second (Mandelstam and Lieber, 1970; Monttcaskle , 1980).

Pressures of swallowing - Data from Gould and Picton, 1964, 1968; Proffit et al. 1964; Lear, 1968; Lear and Moorrees, 1969; Proffit, Chastain and Norton, 1969; 1930; Jones, 1972 reveals considerable individual variation in labial and lingual pressures. A given individual tends to reproduce himself rather well in this respect, but subjects who are similar in dental and anatomic characteristics may exert quite different pressures with tongue or lips.

a) Lingual pressures - measured using pressure transducers, the lingual pressure against the maxillary incisors and anterior hard palate during normal swallowing is 75 50 g/cm . Pressure by the tongue tip is typically exerted for one second during a swallow, but the pressure rises to a peak and falls away, so that the area under the pressure curve or 'time-pressure integral' is a better measure of the pressure - time relationship. For each swallow, the figure is 50 $\pm$ 25 g.sec/cm^2. Pressures exerted by the sides of the tongue against the hard palate in the molar region are somewhat higher, 140 $\pm$ 50g/cm^2 and 100 $\pm$ 30 g.sec/cm^2 being typical. In spontaneous swallowing, the mean pressure is approximately 40 g/cm^2 as compared with 50 g/cm^2 for drinking water, and 95 g/cm^2 for 'dry' swallowing of saliva. Lear and Mooress (1969) report that the average lingual pressure on the dental arch per day is equivalent to 0.1 g acting continuously. The resting pressure between swallows is 2-4 g.

b) Lip and cheek pressures - the perioral muscles of cheeks and lips exert pressure on the teeth of 4 g/cm^2 on molars 6 g/cm^2 on upper incisors and 8 g/cm on lower incisors (Winders, 1958). These are lower than lingual pressures in all areas.

c) Labial pressures during swallowing - these are highest at the corners of the mouth in the premolar region. For subjects with normal occlusion, they average 140 $\pm$ 40 g/cm^2

in the maxilla, 115 $\pm$ 35 g/cm^2 in the mandible. Pressures in the molar region are lower, particularly in the maxilla: 80 $\pm$ 25 g/cm^2 in the mandible, 30 $\pm$ 15 g/cm^2 in the maxilla. Lip pressure against the central incisors is about the same in both arches, approximately 55 ± 20 g/cm^2 . Lip pressures tend to be somewhat higher in the anterior and premolar regions in individuals with class II/I malocclusion.

Pharyngeal stage of swallowing:

When the bolus of food is pushed backward in the mouth, it stimulates swallowing receptor areas around the opening of the pharynx, especially on the tonsillar pillars and impulses from these pass to the brain stem to initiate a series of automatic pharyngeal muscular contractions as follows:

(i) The soft palate is pulled upward to close the posterior nares, thereby preventing reflux of food into the nasal cavities.

(ii) The palatopharyngeal folds on either side of the pharynx are pulled medial ward to approximate each other. Thus these folds form a sagittal slit through which the food must past into the posterior pharynx. This slit performs a selective action, allowing the masticated food to pass with case while impeding the passage of large

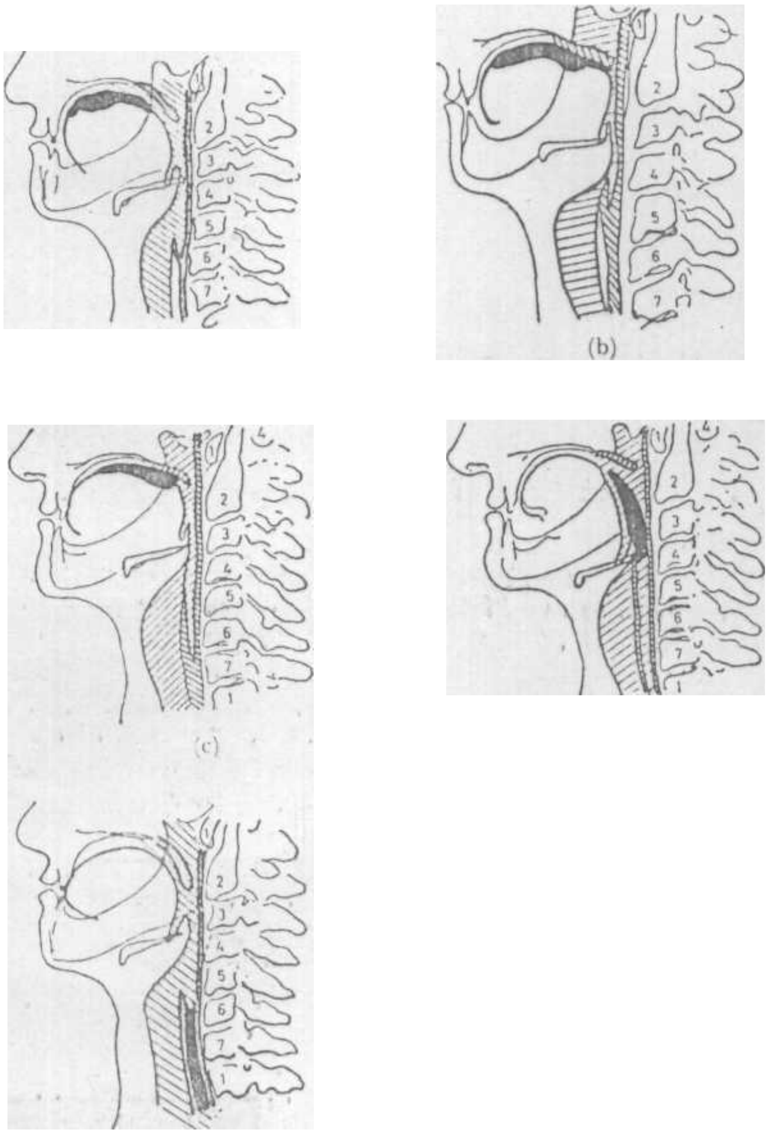


Fig. 5 : Phatryngeal phase of swallowing (after Barclay, 1930)

a) Commencement of swallowing-bolus between tongue and palate, soft palate elevating, larynx elevating;
b) Nasopharynx closed off pharynx and larynx closed;
c) Pharynx opening in upper part - laryngeal pharynx drawn up.
d) bolus passing through the pharynx –sliding past epiglottis;
e) Larynx and pharynx return to normal position - bolus enters pharyngeal end of esophagus.

objects. Since the pharyngeal transit time - the time elapsed from the triggering of the swallowing reflex until the bolus passes through the crico-pharyngeal muscle or past the pharyngo esophageal segment lasts less than one second (Blonsky, Logemann, Boshes and Fisher, 1978; Mandels, 1970), any large object is usually impeded too much to pass through the pharynx into the esophagus.

(iii) The vocal folds are strongly adducted and hyoid and larynx are pulled upward and anteriorly by the neck muscles causing epiglottis to swing backward over the superior opening of the larynx. This prevents entry of bolus into the lower respiratory tract.

(iv) The upward movement of the larynx also stretches the opening of the esophagus. Simultaneously, the upper esophageal sphincter -- the pharyngo esophageal segment relaxes, thus permitting free movement of bolus from pharynx into the upper esophagus. This sphincter, remaining tonically and strongly contracted between swallows, prevents air entry into the esophagus during respiration. The upward laryngeal movement also lifts the glottis out of the mainstream of food flow so that the food usually passes on either side of the epiglottis rather than over its surface, adding yet another protection to the lower respiratory tract. If the bolus is large, the larynx is pulled further forward to accommodate it and the 2 channels become one posteriorly (Lund, 1987).

(v) The instant marking the laryngeal elevation is marked by relaxation of the P.E. sphincter. The superior constrictor muscle contracts, giving rise to a rapid peristaltic wave passing downward over the middle and inferior pharyngeal muscles and into the esophagus, which also propels the food into the esophagus. The above sequence applies to swallowing in erect posture.

In swallowing with head turned laterally, the bolus is deflected down the lower lateral food channel on the side opposite that to which the head is turned, the whole of an average sized bolus may be swallowed down that lateral channel. On swallowing in supine position the bulk of the bolus is still directed to the side of the larynx, but it takes a relatively posterolateral course; the laryngeal opening which is situated anteriorly is not necessarily surrounded by the bolus unless the amount swallowed is large. The course of the bolus is likewise influenced by the gravity when lying in prone or on one side.

Esophaqeal phase of swallow :

This is introduced by passage of the bolus through the cricopharyngeal sphincter. True peristaltic movements then move the bolus through the upper part of the pass age way. The peristaltic wave may be replaced as the propulsive force in the distal parts of the channel by simultaneous contraction along lower segments (Vantrappen and Hellemans, 1967). During this phase, the tongue, palate and hyoid bone return to their presnt allow positions.

These phases of deglutition as seen from this review (Fletcher, 1970; Weinberg, 1970; Gallender, 1979; Jonez,1979; Guyton, 1986; Lund, 1987 and others) implicate the complex integration of this automated processes in effecting the orderly sequence of movement patterns, being coordinated by an intricate spatio temporal relations of the neural and mechanical events.

Development of normal swallowing - oral phase:

The oral phase of swallowing, described by direct observation, cineradiographic studies, palatographic and lingual pressure studies indicate that swallow is different in infants and adults. Bosma (1935); Farrieux and Milbled (1967) report that the classic cineradiographic description of the suckle swallowing in newborn involves a position with the head extended and the tongue low in the mouth, extending anteriorly under the teat to contact the lower lip. The jaws are relatively wide apart and the lips purzed around the nipple. As the liquid collects on the tongue, a wave of peristaltic - like activity carries it backward along the center of the tongue and propels it into the oropharynx. The jaws remain apart And lip activity continues during the swallowing act. Owing to lack of teeth, the tongue is free to extend between the gum pads. The initial attempts by the infant to ingest solid foods are in the form of suckle movements. These movements are characterized by elevation of the mandible and forward thrust of the tongue in contact with the lower lip to elevate the bolus crudely to the dorsum of the tongue and transport it into the swallow - preparatory position (Bosma, 1957).

As the oral cavity expands through growth, the intrinsic lingual musculature matures and becomes capable of mare refined movements, and the teeth erupt to serve as the new potential source of sensory input, new sets of reactive responses may be anticipated. Wassilief (1886) described two patterns of lingual reflex suggestive of reorganisation. Mucosal stimulation by touching or rubbing the surface of the infant tongue elicited suckling movements in the infant. Repeatedly touching or rubbing the adult tongue caused it to curve into the shape of a spoon, the latter posture being the typical site where the bolus collects in the mature preparatory swallow.

The addition of dental occlusion provides an important new source of stabilization for swallowing. Sensory feedback from the teeth in occlusion during swallowing could signal the presence of a new avenue to achieve a stable postural balance of the oral cavity and thereby release the tongue for more precise control of the bolus during deglutition. Proffit, Chastain, and Norton (1969) based on myomatric data suggested that there are two patterns of swallow intermediate between the traditionally described infantile and adult patterns. These patterns consisted of a tongue thrust with teeth apart, and tongue thrust with teeth in occlusion. The adult pattern probably emerged from the latter movements.

Within the foregoing frame work, the tongue thrust pattern of oral activity could represent either a form of developmental arrest or regression to a less mature phase of physiologic function. Thus, lack of neurological competence in a child demanded to segment the lip-tongue-mandible complex in response to the changing cues from an expanding oral cavity, would cause him to remain in an extensor thrust - like swallow pattern (as seen in cerebral palsy). Alternatively, if the neurologic maturation progressed adequately, but the geometric configuration of the mouth or the tongue did not change sufficiently to provide appropriately different sets of new sensory cues during critical development period, the swallow pattern would remain at less than mature level. Finally, trauma to the neurological system may precipitate regression to previous patterns of oral cavity, including the tongue thrust swallow, as the earlier sensory cues reestablish their province.

IV. DYSPHAGIA AND THEIR REMEDIAL STRATEGIES IN CEREBRAL PALSY AND OTHER EATING HANDICAPS:

Impairment of central nervous system precipitates disturbance in the complex and coordinated oroneuromotor behaviour evidenced in dysphagia and dysarthria. Dysphagia in the cerebral palsied may be evident from the time of birth necessitating alternate feeding methods like tube feeding in the presence of weak feeding reflexes with choking and aspiration due to incoordinated swallowing reflex and respiration (Scherzer and Tchamuter, 1982). In the cerebral palsied(CP) population, adaptability of feeding behaviour is often poor, restricting the infant to rigid feeding procedures and limited diet, often resulting in nutrition deficits (Stark, 1985). Also, the primitive and exaggerated feeding reflexes may persist, resulting in stereotyped feeding behaviour interfering with oral physiology during development. The current section overviews the dysfunctions at the three stages (oral* pharyngeal and esophageal) of deglutition and their respective therapeutic regimen, in symptoms alleviation as reported in the literature on cerebral palsied and dysphagics in general.

1. Involvement of the oral preparatory phase:

Food imbibition and buccal closure: Anterior lip seal is vital in skills of ingestion, retention, communication and transportation and swallow (Mavinakere and Sivananthan, 1986). This could be a key factor in the development of feeding skills in cerebral palsied (Treharne, 1980). Labial involvement in this group pertains to -

(i) Deviation from the normal lip movement with labial immobility on protrusion and retraction (Hixon and Hardy, 1964; Hardy, 1983).

(ii) Lack of adequate lip closure (Hoberman and Hoberman, 1960; Rutherford, 1961; McDonald and Chance, 1964).

(iii) Excessive habitualized mouth opening (Crickmay, 1981).

(iv) Tense and retracted lips (crickmay, 1981).

(v) Stark (1985) reports that inability to form labial closure during feeding or at rest after six months of age may be suggestive of labial weakness and may predict difficulty in the production of bilabial stops/labiodental fricatives.

Remediation strategies: Intervention techniques in obtaining labial closure include placement of the child in prone position in the act of mastication and swallowing necessitating retention of the bolus (Hoberman and Hoberman, 1960); stimulation of orbicularis oris by activating the motor fibers of the facial nerve employing brushing, stretching,stroking, vibration, icing, sucking exercises (using clear ice) hot-cold alternation, isometric exercises, use of plastic disk with straw placement in a hole to promote oral closure for any feeding handicapped (Gallender, 1979). Also included are techniques in increasing labial sensitivity and awareness of its position using negative practice (Crickmay, 1981) and physical tapping of upper lips (Gallender, 1979).

Involvement of the masticatory system: Functional disturbances of the stomatognathic system are characterized by -

(i) hypertonicity or weakness of the muscles.

(ii) pain in the joints, teeth or masticatory muscles;

(iii) hyperfunction (bruxism) (Poulsen, Olsson, 1966). In the cerebral palsied, involvement of the masticatory system may range from minimal to severe disfunction; for instance. Love, et al (1980) in a study on severely handicapped spastics and athetoids reported that "...biting and swallowing offered almost no hazards to the majority chewing a soft and firm bolus of food was accomplished by well over four-fifth of the sample."

Grossly categorizing masticatory involvement may relate to:

(i) Malocclusion

(ii) Problems with lingual maneuvering

(iii) Problems pertinent to mandibular movement.

(i) Malocclusion: The condition and shape of teeth being impaired in combination with tongue thrust and abnormal sucking patterns results in malocclusion in the cerebral palsied including open bite, overbite and crossbite. These in turn aggravate abnormal biting and chewing pattern (crickmay, 1981).

(ii) Problems with lingual maneuvering: Deviances in the cerebral palsied include the following which may contribute to oral dysphagia -

a) Deviation from normal tongue mobility in attempting to lateralize when protruded (Hixon and Hardy, 1964? Hardy, 1983).

b) Tongue restriction ranging from movement as an inflexible mass to mildly impaired gesture appearing slightly slowed and imprecise. This may hump anteriorly with lingua-alveolar contacts being made with the tongue blade against the alveolar ridge, with no discernible tongue tip elevation. Likewise, there occurs a posterior humping for lingua - palatal contacts (stark, 1985). In both the instances, a major contribution to lingual elevation is the associated mandibular movement (Yost and McMillan, 1983, Stark, 1985).

c) The articulatory deviances associated with thesegestures include inability to produce retroflex sounds, appropriate lingual placement for the consonant /r/ and vocalic /r/ and distortion of vowels (Stark, 1985).

In the oral dysphagics the deviances include -

a) Inability to lateralize the food material with tongue and place it onto the grinding surface of the dentition.

b) Inability to mash the material, with compensation by vertically crushing the food between tongue and palate implicating reduced tongue elevation (Logemanp,1986).

c) Weakness of the lingual musculature together with facial musculature results in retention of food on one side of the oral cavity while eating (steefel, 1981). The food may fall into the anterior or lateral sulcus indicating reduced labie-facial tension (Logeman, 1986). Swallowing behaviour from the opposite side is seen in clients with unilateral lingual weakness (Lund, 1987).

d) The reduced range or incoordination of lingual movements prohibit collection of chewed material spread out in the oral cavity into a cohesive bolus.

e) This may cause aspiration, owing to premature loss of bolus into the pharynx.

f) Also, clients may initiate swallow with food spread out throughout the oral cavity (Logeman, 1986).

g) Abnormal Hold position with bolus being held against the front teeth or on the floor of the oral cavity with lingual retraction may be accompanied by tongue thrust swallow with the bolus being pushed forward. Strong tongue thrust may head to bolus expulsion outside the oral cavity (Logemann,1986).

Management cells for employment of lingual exercises (isotonic,isometric).

(iii) <u>Problems with mandibular movement</u>: These include -

a) Persistence of primitive phasic like reflex (palmar, 1947; Crickmay, 1981; Scherzer and Tcharnuter, 1982) with an rhythmical bite and release pattern with vertical movement of the jaw.

b) Absence of chewing reflex (Crickmay, 1981; Stark, 1985).

c) Absence of voluntary biting and chewing (Stark, 1985).

d) Restricted mandibular opening with jaw deviation to the weaker side or to the side with greater speticity.

e) Jaw movements are typically slowed (Stark, 1985).

f) Mandibular movement may be effective enough to accomplish compensatory movement to assist labial and lingual gestures (Stark, 1985).

g) Extensor thrust with spastic jaw is a frequent finding (Stark, 1986).

h) "There appears to be a relationship between the mouth opening pattern and the mandibular facet slip (MFS) often seen in C.P. population. Nature of the mouth opening pattern is hyperextension of the mandible" (Sheppard, 1962). The tonic mouth opening may be maintained by secondary subluxation rather than continued muscle spasm (stark, 1985).

i) Lack of jaw usage may result in stiffness and decreased movements at the temporomandibular joint which may be marked if the client has resorted to tube feeding. This may also precipitate secondary contracture in the muscle (Stark,1985).

Therapeutic techniques:

(i) The bite reflex can be facilitated (in severe CP clients using the principle of Stimulation development principle of emergent reflexes) (Mysak, 1960) which is then inhibited (crickmay, 1981).

(ii) To eliminate bite, position the head in an upright posture with chin tucked slightly in. Use spoon with vinyl coated bowl, minimum food being placed anteriorly and inserted laterally into the oral cavity. Desensitize the reflexogenic zones by repeated stimulation—rubbing, stroking, etc. (Gallender, 1979).

(ill) Facilitate chewing reflex by providing food that requires chewing, with initial placement on the molars (Palmer, 1947, Gallender, 1979); pressed laterally across the hard palate (Crickmay, 1981). In presence of weak chewing, stimulate the reflex by rubbing the gingivum and dentition of both the jaws with finger, 1st anteriorly then sides and backwards.

(iv) If jaw deviation is present, employ passive movement in Reflex Inhibiting Postures (RIP) (Crickmay, 1981).

(v) Vigorous stimulation of masticatory muscles - temporalis, masseter and medial pterygoid facilitates chewing, stimulation of the masseter is not employed in presence of bite reflex (Gallender, 1979).

Involvement of oral swallow: Neurological disturbances result in

a) Hyposensitive palate which precipitates crude patterns of food manipulation and swallowing (Ray and Santos, 1954).

b) Disruption in the tactile sensory control and coordination of swallowing because of inadequate underlying skeleto-dental configuration (Cleali, 1965).

c) Gross nearomuscular deficiency which includes a tongue thrusting movement as part of generalized extensor thrust (Ingram, cited by Hopkin, and McEven, 1955? Palmer, 1948) as seen in cerebral palsied.

d) Moderate motor disability and loss of precision in oral function (Strang and Thompson, 1958; Shelton, Haskins and Bosma, 1959; Bloomer,1963)

The signs/symptom complex evidenced by involvement of this phase include:

(i) **Tongue thrust swallow** - etiology of tongue thrust include neurologic maturational, genetic factors, mechanical restriction, learned behaviour psychogenic causation etc. (Fletcher, 1970). In the syndrome of cerebral palsy, tongue thrust may be a part of the generalized extensor thrust (Palmer, 1948? Hardy, 1983). Symptomatology associated witn tongue thrust in general include :

a) Characteristic vigorous pressing of the tongue against or between the teeth either anteriorly or posteriorly (Palmer, 1962).

b) Differences in neuromuscular patterns of swallow Including insufficient elevation of the tongue during any part of deglutition with resultant sucking movement.

c) This sucking is made possible by the increased circumoral tension (Whitman, 1951; Barrett, 1961; Fletcher, Casteel and Bradley, 1961) with the upper lip exerting double the pressure in tongue thrusters than in nontongue thrusters (Akamine, 1962 and Mendel, 1962).

d) Minimal laryngeal excursion (Palmer, 1962), usually anterior only. Few direct superior or posterior movement may be present.

e) Presence of "anesthetic throats" (Palmer, 1962). With an apparent decrease in gag reflex not significantly hampering the client.

f) Orofacial structural differences include high palatal vault together with a narrow maxillary dental arch, with prominent palatal rugae (plicae) evident immediately posterior to the incisors unlike that seen in normally elevated tongue during deglutition (Palmer, 1962). Others include flaccid upper lip, flaccid masseter and temporalis muscles, firm mentalis muscle (Harrington, Barrett, cited in Palmer, 1962) and malocclusions including anterior overbite, posterior or molar maocclusion - Angle's classification II (Palmer, 1962).

(ii) Stasis of food in the anterior sulcus - This during the oral phase of swallow implies reduced bucco-labial tension and poor lingual control (Logemamn,1986), seen in oral dysphagics.

(iii) Stasis of food in the lateral sulcus - also called the parking bolus (Jones, 1979), large residue in the vestibule is implicative of reduced tension in the buccal musculature (Logeman,1986). This aids in backward movement of the bolus during oral transit by provision of inward pressure in oral cavity (shedd, Scatliff and Kirchner, I960).

(iv) Stasis on the floor of the mouth - falling of food onto the anterior - lateral floor of the mouth during attempts at oral transit is an indicator of reduced lingual manipulation of the bolus in its posterior movement (Logeman, 1986).

(v) Stasis in a midtongue depression - this is usually implicative of scar tissue on the lingual surface (Logeman, 1986).

(vi) **Stasis of food on the tongue** - This is an indication of reduced lingual movement despite attempts to initiate a swallow,usually seen for food of thicker consistency (Logemann, 1986).

(vii) **Incomplete linguo-palatal contact** - This is implicative of restricted lingual elevation. This may also result in disturbances in lingual peristalsis (Logemann, 1986).

(viii) **Adherence of food to the hard palate** - This is also implicative of reduced tongue elevation.

(ix) **Uncontrolled bolus or premature loss of food into the pharynx:** This occurs prior to triggering of the reflexiv< swallow by the main portion of the bolus with resultant aspiration owing to the open airway (Logemann, 1986).

(x) **Slow transit time** - This with delayed swallowing reflex is common in cerebealar disorder (Vrtali, 1986) .

(xi) **Piecemeal deglutition** - This even for small quantity of bolus implicates fear of swallowing as the client meters out small quantities of food to be swallowed to prevent aspiration (Logemann, 1986).

(xii) **Assistive head tilt** - This as a compensatory mechanism during bolus manipulation and swallowing are common in

CP population (Mavinakere, 1986). This is also referred to as 'bird-like' head and neck movement (Palmer, 1962).

(xiii) Drooling - This is a common problem encountered in the cerebral palsied which is rarely due to excessive production of saliva from excitation of the salivary mucleus, but usually due to the failure of the tongue to direct the saliva backward (as in normal swallowing mechanism) to trigger the swallowing reflex (stark, 1985).

Special considerations:

This section deals with specific conditions like sucking through straw, drinking through cup, spoon feeding etc. . demanding close coordination between oral and pharyngeal structures. For instance, all of these conditions may be accompanied by drooling owing to first and second phase involvement in cerebral palsied due to -

(i) Poor labial closure (Ward, Malone, Jann and Jann, 1964; Gratke (1947); Hoberman, and Hobeaman, 1930; Westlake and Rutherford, 1961; McDonald and Chance, 1964).

(ii) Tongue thrust swallow.

(iii) Lack of initiation of swallow reflex - (Gratke, 1947? Palmer, 1947).

(iv) Excessive salivation (Stark, 1985).

Therapeutic intervention calls for -

(i) Postural maintenance at the typical forward bent swallow position (Crickmay, 1981). Hoberman and Hoberman (1960) also suggest placing the child in prone position with a mirror placed beneath the face for visual monitoring.

(ii) Labial exercises (Gallender, 1979).

(iii) Lingual and bulbar exercises.

(iv) Initiating a normal rate of swallow (about 2/minute) by stimulating back of the tongue or palate with a small tongue depressor? directing a stream of water from an eyedropper against posterior pharyngeal wall with the head in moderate dorsiflexion and encouraging token coughing (Mysak, 1963).

(v) Awareness and replication of all the physiological events in swallow (lip contraction, masseter contraction, velar and laryngeal elevation and lingual positioning and movements) (Gallender, 1979).

(vi) Use of feedback systems (Garber, 1971) like drooling activated auditory signal indicating the need for voluntary swallow.

(vii) Use of drugs like propanthaline which occasionally reduces the amount of saliva secretion, thereby preventing drooling (Stark, 1985).

(viii) Persistent siallorrhoea (which may cause chronic eczema (Sittig, 1951) calls for recession of the salivary ducts back into the oropharynx aiding in backward movement of the saliva (Wilkie, 1967; 1970; Ekedahl (1974); Goode and Smith, 1978)

Oral intake of liquids and solids:

Some of the faulty feeding techniques employed by the parents of the cerebral palsied infants promote the persistence of primitive/abnonnal feeding behaviour which ought to be given due consideration in the therapeutic management of dysphagia. These faulty habits include -

(i) Tilting the head backward to promote assistance by gravity during swallow.

(ii) Maintenance on soft baby foods placed at the back of the tongue for children with difficulty in manipulating the tongue. This also prohibits the attempts to maneuver the tongue to propel food from front to back of the mouth for swallow. Combination of poor labial closure and deficient tongue movement results in drooling and lack of stimulation of the swallow reflex (Hoberman and Hoberman, 1960).

A. Intake of liquids: In the treatment procedure for safe oral intake of liquids, due considerations ought to be given to the client's posture, the precise diet level, itemized list of special equipments required for feeding, precautions/techniques needed to feed the client including the provision of instructions, the consistency of liquid permissible for safe oral intake for instance, the items from the diet manual promulgated by Steefel, 1981,inclusive of dysphagia liquid NPO, dysphagia extra thick liquids, dysphagia minimally thickened liquid, dysphagia clear and other liquids.

Sucking behaviour in C.P: Sucking through stzaw is a particularly difficult task for the cerebral palsied (Palmer, 1947; Love, et al.1980). This is attributable to -

(i) The lack of sustained lip closure (Hoberman and Hoberman, 1960; Westlake and Rutherford, 1961; McDonald and Chance, 1964).

(ii) Passive state of lips and cheeks (Ward, Malone, Jann, and Jann, 1964).

(iii) Lack of prolonged velopharyngeal closure (Netsell, 1969).

(iv) Absence of suck reflex (Crickmay, 1981).

(v) Delayed development of sucking,together with lack of muscular tonicity making the sucking action weak.

Therapeutic techniques: Techniques for sucking through straw include facilitation and inhibition of the sucking reflex (Crickmay, 1981); appropriate posturing of the client in the normal feeding posture i.e. slightly forward bent position (Gallender, 1979) or in the Reflex Inhibiting Posture (RIP) lip closure exercises (Gallender, 1979)? alterations in the straw length and circumference positioning and consistency of the liquid (Palmer, 1947; Hoberman and Hoberman, 1960; Steefel, 1981) and use of snap back dental rubber tubing with a shift to cellophane or wax straw with the establishment of voluntary sucking behaviour (Palmer, 1947). Following the laws of physics dealing with fluid mechanics and the effects of air pressure and gravity on fluid behaviour (Marburger and Hoffman, 1955? Zebrowski, 1974), these techniques are based on the premise that -

(i) The amount of vertical rise between the surface of the liquid and the client's mouth affects the strength needed to suck the liquid into the oral cavity, with a shorter straw demanding less strength.

(ii) The horizontal distance the liquid must travel in the straw also affects the strength required for sucking, with a shorter horizontal distance requiring decreased strength.

(iii) More strength is required to suck thick liquids through a straw.

(iv) More strength is required to suck from a straw when the opposite end is partially occluded than when it is open (sucking against resistance)

B. Spoon feeding in C.P: Following are the abnormal oral pattern in spoon feeding as reported by Crickmay (1981); Scherzer and Tchamuter (1982), stark (1985):

(i) Usage of primitive sucking pattern in imbibing food from spoon.

(ii) Usage of tongue thrust pattern with lip retraction for spoon clearance (instead of lip usage).

(iii) Scraping of food along the teeth or gingivum, further reinforcing lip retraction.

(iv) Bite reflex in an uncontrolled tonic motion in a hypersensitive infant.

(v) Hyperextension of the jaw in response to the approaching spoon.

(vi) Bird feeding pattern.

(vii) Delay in emergence of lip retraction on spoon feeding among many other features may be suggestive of weakness and delay in maturation of oromotor system and may be predictive of dysarthria (Stark, 1985).

Techniques of spoon feeding - These as suggested by Gallender, (1979) for oral dysphagics include reduction of oral stimulation by utilizing spoon with small bowl, decreasing the bite size loaded on the spoon tip, inserted laterally in the oral cavity (in presence of severe tongue thrust).

Remedial techniques for tongue thrust - Retraining procedures for reduction of tongue thrust are borrowed from kinesthesiology and physical therapy principles attempting to -

(i) Hold the tongue from pressurizing the teeth.

(ii) To increase linqual muscle strength.

(iii) To change the muscle bulk of the upper lip and increase muscular activity.

(iv) To do essentially the same for the masticatory group (Palmer, 1962).

The subgoals include coordinating tongue elevation with contraction of the masticatory muscle group, attempting at "lip-apart-but-teeth-accluded swallow" (Palmer, 1962),aborting linqua labial reflex to prevent abnormal swallow (Fletcher, Casteel and Bradley, 1961); elimination of spewing habits? increasing the contribution of posterior oral musculature and decreasing that of circumoral muscles; increasing the involvement of laryngeal musculature, nocturnal or sleep swallowing changes etc. (Palmer, 1962). Gallender (1979) suggests vibration of the frenum,massaging the floor of mouth; desensitizing the tongue? lingual retraction by vibratory stimulation of floor of the mouth, specific methods of spoon usage all performed with the head tilted slightly forward as means of tongue thrust correction

2. Pharvngeal/second phase involvement:

This includes the dysfunction of swallowing reflex or the programming mechanism in the brainstem that organizes and initia the pharyngeal response, or dysfunctions of any of the neuromuscular components that actualize the reflex or characterize the pharyngeal response (Logemant, 1986). The current section highlights these deviances in general and those reported in the cerebral palsy literature implicating pharyngeal phase dysfunction.

(i) **Undeveloped swallow reflex-**(Gratke, 1947; Crickmay, 1981) which in therapy, the CP child ought to learn to produce with conscious effort.

(ii) **Pharynqeal reflex** - i.e. stimulation of fauces with resultant reflexive contraction of pharyngeal constrictors may be weakened in certain cases of dysarthria.

(iii) **Inadequate velar elevation** - with nasal reflux during eating, absence of gag reflex, hyperrhinolalia and inability to build up intraoral air pressure (sittig, 1951; Mysak, 1963; Steefel, 1981; Logemann, 1986; Stark, 1985).

(iv) **Diffuse falling of material over the base of the** tongue (Logemann,1986).

(v) **Vallecular stasis** or falling of bolus onto the pyriform sinuses (Logeman, 1986).

(**vi)** **Coating of the pharyngeal wall** with food material after swallow (normals employ a dry/empty swallow to clear this)

(vii) **Reduced laryngeal closure** which normally occurs at three levels, viz. the aryepiglottic folds,epiglottis, false vocal cords and true vocal cords (Logemann,1986).

(viii) Reduced laryngeal elevation with a resultant aspiration during the act of swallowing.

(ix) **Incoordination between respiration and deglutition** - In neurologically impaired infants, the interaction between sucking, breathing and swallowing may be disorganized leading to choking and aspiration. Infants with CNS lesion often rely on month breathing instead of nasal respiration which increases the danger of swallowing air and aspiration (Scherzer and Tcharauter, 1982). Also, since nasal respiration requires approximation between tongue and soft palate, a motor disturbance in these areas may contribute to patterns of abnormal breathing (Scherzer and Tschamuter, 1982).

Postswallow voice evaluation (phonation of vowel /a/ for two seconds) aids in ascertaining the entry or otherwise of the food material into the larynx, with a wet gurgle suggestive of food on or close to the vocal cords (Steefel, 1981).

Remediation strategies: Therapeutic methods in handling the pharyngeal dysphagics offer no single effective oral feeding technique for bypassing this swallowing difficulty (steefel, 1981). Thence, symptom alleviation rests on handling the individual systems (velopharyngeal and laryngeal) differentially as follows:

(i) Swallow reflex - treatment is geared towards facilitating the swallow reflex (Gratke, 1947) and inhibiting it (Palmer, 1947) i.e. bringing it under voluntary control eg. by employing the chewing technique. Mysak (1963) reports of stimulating the back of the tongue or palate with a small tongue depressor and directing a stream of water from an eyedropper against the posterior pharyngeal wall with the head in moderate dorsiflexion as means of stimulating swallow reflex.

(ii) Velar elevation - Techniques of palatal strengthening include -

a) Froeschel's chewing technique, reported by Sittig (1955) in reduction of hyperrhinolalia.

b) Pushing exercises (Froeschels et al. 1955; Brodwitz, 1965).

c) Regular periodic attempts at stimulating palatal, pharyngeal and yawning reflexes. Velar stroking accompanying these efforts may be found to be of assistance (Mysak, 1963).

d) Another exercise for strengthening palatal musculature involves having the client to suck an empty straw against resistance by closing the opposite end of the straw, performed three or four times a day for a short period of time (Steefel, 1981).

e) Surgical management of palatal paralysis and speech problems (Hardy, Spriestersbach, Jayapathy, 1961).

(iii) Monitoring laryngeal elevation and closure during deglutition

a) For clients with impaired second stage of degluttion, the second swallow technique involving dry/empty swallow aids in completing the inadequate first swallow (steefel, 1981).

b) Voluntary coughing after each bite ensures safe swallow (Mysak, 1963; Steefel, 1981). This can be facilitated by pantomiming cough production by the clinician. Additionally, Valsalva's maneuver (Broadnitz, 1965; Froeschels et al. 1955; Luchsinger, and Arnold, 1965) inducing thoracic fixation and building up of Intrathoracic pressure aids in initiating a tough.

3. Esophageal/third phase involvement:

Hallmark of termination of the second stage and initiation of third stage of deglutition is the relaxation and subsequent contraction of cricopharyngeus musculature and simultaneous elevation of larynx and glottic closure. Cricopharyngeus malfunctic with dysphagia and aspiration can be consequent to neurological impairment. Following are the symptoms in dyaphagics (not reported in CP literature) demonstrated on cricopharyngeal dysfunction (Steefel, 1981; Stark, 1985):

(i) Client has normal oro-motor function for swallowing and articulation.

(ii) Reports of pain and regurgitation during or post swallow,

(iii) Aspiration, without the occurrence of apnoeic pause of 0.5-3.5 seconds during swallowing is suggestive of esophageal stage dysfunction.

(iv) Client exhibits difficulty in handling his own secretions and requires frequent auctioning.

(v) Client is disallowed oral intake (NPO) and an alternate feeding method is instituted for nourishment.

(vi) Client demonstrates weak or absent cough (voluntary/ reflexive)

(vii) Efficiency of intake of thin liquids is better than for items with thicker consistency.

Treating the cricopharyngeal dysphagic: Treatment modes available include two alternatives, viz:

(i) Therapeutic approach with specific exercises in combination with a controlled diet.

(ii) Surgical relaxation (myotomy) of the upper esophageal sphincter (schultz et al. 1978, 1979).

Therapeutic approach to treatment prior to surgical management is recommended. These exercises include -

(i) Prefeeding techniques to instruct the client for limiting the amount of bolus intake, safety procedures and general information regarding swallowing process and the nature of his particular problem.

(ii) Dry swallow and second or even third empty swallow following each bite compensates for the inadequate relaxation of cricopharyngeal muscle.

(iii) Exercises to promote vocal fold adduction including pushin< exercises and production of voluntary cough and sigh.

Schultz et al. (1978, 1979) recommend the following six-step pattern of activities to compensate for lack of vocal cord adduction. The client is required to:

a) "Breathe in"which brings about vocal fold abduction?

b) "Hold" the air, requiring glottal adduction.

c)"Swallow" requiring both opening and closing of the glottis.

d) "Breathe out" bringing about abduction.

e) "Cough" requiring abrupt glottal closure? and

f) "Swallow" using saliva or a minute quantity of water.

(iv) Use of straw is contraindicated owing to the normal oro-motor function and ability to suck in large quantity of fluid by this means. The client is instructed to suck small amounts of liquid from teaspoon. The latter ensures elicitation of swallow reflex and maintenance of safe posture for swallowing.

(v) Unlike the oropharyngeal dysphagics, the diet progression is from thin to thicker liquids and pureed solids.

METHODOLOGY

The present study was directed at exploring the extent of physiological integrity of the stomatological structures by:

(i) Obtaining a developmental profile of deglutition

(ii) Probing into the relationship between speech performance and deglutition.

(iii) Enlisting the deviant (or otherwise) patterns of deglutition in the spastics, these deviant patterns constituting the oral pharyngeal dysphagia.

The study was conducted in three stages:

I. Development of test protocol

II. Administration of the test.

III. Rating of the responses obtained using a semiquantified scale developed for this purpose.

Development of the test protocol:

A pilot study evaluating deglutition was conducted on two normal adults and five normal children; age ranging from 2-9 years (Data was retained for further analyses). The subtests of deglutition, on the basis of feasibility of testing, were selected from literature, together with general observation of deglutition in naturally occuring conditions.

Food item selection: This incorporated easily accessible items ensuring a range of consistency from liquids to solids to highlight the different oral strategies employed in its manipulation. Items included -

Solids:

1. Cooked rice - a common item included in the regular diet.
2. Biscuit - which can be softened quickly by saliva.
3. Rusk - which gets easily fragmented with increased masticatory force, posing problem in cohesive bolus formation, in presence of decreased salivation.
4. Chocolate - requiring exaggerated mandibular motion for chewing to facilitate observation of mandibular.are traversed.

Liquids:

Only water was selected, owing to accessibility and ease of observation of oral maneuvering.

Table-2: Test protocol for evaluation of speech and deglutition

Sl. No.	Parameters evaluated	Subtests
I.	History, extra and intra oral examination	- History pertinent to feeding. - Routine extra and intra oral examination.
II.	Speech performance.	
A.	Articulation.	- Kannada speech sounds in isolation. - Items from test of Articulation in Kannada - diagnostic(Form-B) (Rathna, Babu, Bettager, 1972).

B. Voicing - Subjective evaluation.

III. Deglutition

A. Eating

1. Natural eating
- Imbibition
- Biting
- chewing
  Mastication
- Swallowing - oral
  - Pharyngeal

Post swallow voice evaluation

2. Simulated, interrupted condition
- Imbibition: Maneuver employed
- Biting: (a) dentition used
  (b) reflexive/voluntary.
- Chewing: (a) chewing sound
  (b) Labial movements
  (c) Detection of food position.
  (d) Spillage
  (e) Mandibular arc traversed.
  (f) Lingual movement
  (g) Masseter contraction
  (h) Chewing efficiency
  (i) Food clearance from labial surface.
- Swallowing: (a) Anterior and posterior seal - cohesive bolus.
  (b) Laryngeal. elevation
  (c) Masseterr contraction

(d) Circumoral tension

(e) Lingual positioning

(f) Mandibular stability

(g) Gulp

(h) Others.

Post swallow intra-oral examination.

B. Drinking

- Natural
- Simulated interrupted condition

- Imbibition (a) Through pouted and unpouted glass
  - Position
  - Lip protrusion
  - Cheek indrawing
  - Amount of water consumed in three trials.
  - Others.

  (b) Through straws
  - Position
  - Angling
  - Tongue thrust observation
  - Others
- Swallowing (a) Anterior and posterior seal (structure and adequacy)

  (b) Swallow reflex

  (c) Laryngeal displacement

  (d) Circumoral tension

  (e) Lingual positioning

  (f) Mandibular stability

  (g) Gulp

Post swallow voice evaluation.

Administration of the test:

Subject selection: The test protocol formulated was administered to three sample groups which were as follows:

Group-1: Consisting of 12 normal adults females, randomly chosen, age ranging from 17-22 years.

Group-2: Consisting of 35 randomly chosen normal children, age ranging from 2-9 years. Upper limit of 9 years was chosen in lieu of observation in the pilot study implicating adult patterns of deglutition in this age group; and lower limit for age group as 2 owing to the ease of instruction and cooperation for testing; also considering the age group at which C.P. children are brought to clinics for therapeutic intervention (unless severe). This group was divided on age basis into seven sub-groups of five each (2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9 years). The subjects fell in middle to upper socio economic strata, of both sexes meeting the following criteria of -

(i) being otologically normal;

(ii) having no speech delay or deviance (except in lieu of the developing phonology in the latter group).

(iii) being at least of average intelligence;

(iv) having no upper respiratory/alimentary tract infection at the time of testing.

Group-3: was inclusive of verbal, normal hearing, minimal to moderately severe spastic cerebral palsied, age ranging from 3.5 - 13.5 years with no significant mental retardation contributory to speech delay, falling in mid to high socio economic status. Table-3 provides the client details.

Table-3: Spastic: cerebral palsy sample - client details

Client No.	Age (years)	Sex	Socio-economic status (SES) (M=middle? U=upper)	Degree of oral involvement
CP 1	9.7	Female	MSES	Minimal
CP 2	3.5	Female	MSES	Mild
CP 3	4.2	Male	MSES	Mild
CP 4	4.6	Female	MSES	Moderate
CP 5	5	Female	MSES	Moderately severe
CP 6	7.8	Female	USES	Moderate
CP 7	13.5	Male	MSES	Moderate

Sessions for test administration: Client testing was indlvi- dualized -

(i) To facilitate observation of emitted/elicited responses

(ii) To reduce subject sensitization, thereby decreasing the influence of one subject on the other on patterns of speech and deglutition.

(iii) To minimize distraction.

The test was administered in their respectivehome setting with audio, visual and olfactory distraction minimized.

Procedure: The test protocol outlined in the previous section (Table-2) was administed as follows:

History, extra and intra oral examination: History pertinent to feeding was taken including details of presence and duration of intraoral habits of thumb/finger sucking and tongue thrusting. Details were obtained from parents of the cerebral palsied regarding the types of difficulties encountered in feeding the child, history of aspiration and choking, details on alternate feeding methods (like nasogastric tube) if employed during infancy. Additionally, the mother was required to demonstrate the posture adopted for feeding and the method of feeding including the size of bolus, type of food used, mode of presentation into the oral cavity and the utensils used.

Routine oral examination was performed including structural and functional evaluation (tonus; gnathic, labial and lingual posture at rest, mobility etc) of the active and passive articulators. In presence of evidence of thumb sucking, additional note of callus formation, cleansed, and blunt nails was made.

Table-4: Evaluation of speech performance

Sl. No.	Parameters tested	Procedure
A.	Articulation: In the context of this study, articulation refers to the production of a variety of zounds which are the acoustic representation of the phonological sequence of language and dialect. Any deviation in production of speech sounds not meeting the above criteria was referred to as misarticulation.	* Assessment of Kannada speech sounds in isolation. following a repetition paradigm. * Assessment of vowels in word initial position and consonant articulation in word initial and medial position, using items from test of Articulation in Kannada - Form B (Rathna, Babu, Bettageri, 1972) employing a repetition task. * Modifications in the test procedure were adopted as and when required. For instance,in the younger age group, stimulus words required presentation at reduced rate with frequent repetitions. Elicitation of response at times necessitated prauding. * Responses were recorded on the data sheet and analysed for the SODA errors - Substitution,Omission, distortion and Addition. Additional report on the adequacy/increase/decrease of pressure application at the articulators -- implying tense vs. lax production was also made.
B.	Voicing: This refers to the resultant of laryngeal control of expiratory airflow during speech. In the current study phonation pre and post swallow were assessed to ensure the degree of security of the lower respiratory tract from aspiration of the food material.	* The subject was instructed to phonate /a/ for about 2-5 secs, and the quality of voice was noted. Phonation pre and immediate post-swallow (in the deglutition act) were compared for the change if any, in voice quality. * In presence of voice, change, inthe CP population, an additional assessment of voluntary coughing and to throat clearance was made. * Voice post throat clearance/coughing was compared to post swallow voice quality.

Table-5: Evaluation of deglutition - eating: Natural condition (Self feeding format).

Food materials used - Rice, biscuit, rusk. chocolate.
Utensils used - Standard ice-cream spoon. teaspoon, plate, tongue depress or (Refer to Fig.6 in Appendix-A)

Sl.No.	Delutition act	Procedure	Pertinent observations	Observation modality
1.	Imbibition	* The food material was offered to the client including rice presented with a standard teaspoon and ice-cream spoon. Other items included biscuits, rusk, and chocolate. * No verbal instructions were provided regarding its oral maneuvering to ensure that observation recorded typified the natural act of deglutition.	a) Labial movement in spoon clearence. b) Assistance (finger/hand, head tilt etc) required to direct the food matetial into the mouth.	Purely visual. under adequate illumination.
2.	Biting.		a) b) Reflex + force requried Voluntary	Visual
3.	Chewing		a) Positioning of food. b) Mandibular are traversed c) Range of mandibular motion. d) Force of masseter contraction if visually indicated. e) Mode of bolus retention f) Mode of food clearance from lips.	visual
#.	Swallowing		a) Masseter contraction	Visual if indicated.
			b) Visual indication of circumortl tension. c) Tongue thrust d) Mandibular stability	Visual
			e) Presence of gulp	Auditory
			f) Intra oral examination-post swallow.	Visual

Table-6: Evaluation of deglutition - eating; simulated interrupted condition.

In this,the food placement in the oral cavity was made by the tester, the client beina instra*-ted to cease the deglutition act at different zeguential steps. Oral cavity was examined under sufficient illumination for the corresponding response in that stage. Responses were recorded in the data sheet.

Deglutition act	Testing procedure	Pertinent observation	Observation modality	Rating scale used
Imbibition	Standard ice-cream spoon & teaspoon filled with cooked rice was affered to the subject seated in normal eating posture	* Maneuver employed was noted. Whenever possible,client's subjective report on this activity was also recorded.	Visual + audition (if imbibed with the aid of teethi	3 = clearance with lips alone. 2 = clearance with lips and teeth. 1 = clearance with teeth with lips apart or inability to clear the food material in pathological condition.
	presented in the horizontal position. Subject was required to clear the material off the spoon-	* Efficiency in task performance was noted.		3 = Good, with no remanant food material on spoon clearance 2 = Fair with minimal rem&nant of food material on spoon clearance. 1 = Poor with residue present on spoon or inability to clear the food material off the spoon
Biting	The food materials were offered to the client & the biting act was observed.	* The dentition between which the food material was interspersed during the up and down mandibular movement against the maxill* was noted.	Visual	3 * biting with incisors or canine (speculating on cuspid or premolar biting in presence of diastema) when employed voluntarily in the initial phase of mastication

		* Its occurrence at reflexive or voluntary level together with the force required in pulverization was noted.	Tactual	2 = weak bit with either indent formation or minimal pulverization, delayed response post bolus placement. 1 = biting at a reflsxive level (bite reflex) in the initial masticatory phase, this being continued into the chewing phase.
Chewing	Chewing act of the bitten material, once placed on the grinding surface of the teeth was noted.	* Chewing sound accompanying pulverization of rice	Addition	3 = no accompanying sound 2 = minimal accompanying sound. 1 = marked sound.
		* Labial movement accompanying chewing with the required circum-oral tension to ensure food placement within the oral cavity was noted.		3 = predominantly closed 2 = both labial opening & closure. 1 = marked labial opening + clumsy labial movement.
		* Detection of food positioning: External cues in the buccolabial area in detection of food position during mastication was noted. This was further verified by instructing the client to open his oral cavity and checking for the food position.	Visual Inspection.	3 = Difficulty in detection to very minimal labial pursing to retraction. 2 = minimal cheek bulge + minimal labial pursing + detection through open mouth 1 = bucco labial tension + lip purse + cheek bulging + through

	* Spillage - during mastication, presence or absence of spillage and the predominant side on which it occurred was noted.	Visual inspection.	3 = absent. 2 = minimal spillage. 1 = marked spillage.
	Mandibular arc traversed-tactual information (together with visual supplementation) with tester's hand placed externally across the mandible upto the region of mandibular condyl aided in establishing consistency in the arc traversed --rotatory/side to side/others++	Visual + tactual inspection*	3 = rotatory/side to side. 2 = minimal deviation from the above 2 types, with increased range of movement. 1 = marked deviation from the above 2 types including deviation to one side during chewing,jaw thrusting, bite etc.

++ Rotatory movement implied mandibular motion, antero - inferiorly -> laterally -> postero-superiorly and back to the position of centric occlusion. Side to side movement implied a consistent pattern6f movement in the rotatory fashion with mandible moving to right/left -> centric occlusion -> left/right -> acentric occlusion with cycle repeating.

Consistency implies predictability of direction of jaw movement in relation to food placing and inconsistency implies inability to do so.

	* Lingual movements In the act of mouth opened chewing were noted. - Dissociation of lingual from mandibular movement, variations in tongue positioning etc. were noted.	Visual	3 = tongue placement within the oral cavity with no deviations visually noted. 2 = Tongue fronting with dissociation from mandibular movement. Bolus placed anteriorly in

		the oral cavity (close to incisors and canine) without or with minimal spillage. 1 = no lingual dissociation from mandibular movement, marked lingual protrusion. variation in lingual placement (high vs. low between right and left half) or no lingual maneuvering to shift food to grinding surface of the dentition.
* Masseter contraction- Masseter was palpated to note the degree of contraction.	Tactual (palpation) + visual supplementation if indicated by masseter prominence.	3 = Normal masseter contraction(subjective) 3 = Weak contraction. 1 = Absent masseter contractor.
* Chewing efficiency was established based on the degree of pulverization (particle size)post chewing.	Visual inspection of the chewed food	3 = good (with fine particle size. 2 =: fair (with medium sized Particles) 1 = poor (with large sized or nonpulverized particles)

		* Labial surface clearanee while chewing in presence of spillage was noted? in its absence, jam was smeared on the lips and the client was required to clear it off with no prior directions regarding the same.	Visual	3 = labial pursing + minimal lingual protrusion + hand usage. 2 = lip versus teeth + lingual protrusion. 1 = lip vs. teeth + hand/finger usaoe + tongue protrusion. Underlineditems are the predominant observation occuring in atleast 2 out of 3 trials.
Swallowing	* Anterior seal was checked by parting the clients lips (when circumoral tension was leas) and observing through diastema or employing slight mandibular depression with instruction to maintain tongue posture(Fig.7 Appendix-A)	* Cohesive bolus formation implicating lingual maneuvering efficiency was noted i.e. whether the bolus was compact or diffuse	Visual	3 = Cohesive bolus formed 2 = Contours of bolus is not marked, with minimal spreading of food material close to the main bolus. 1 = bolus present elsewhere (sublingually, adhered to palate, in the anterior/lateral sulcus) on posterior pharyngeal wall (Fig.6 Appendix-A)
	* Laryngeal elevation during the act of swallowing was observed placing the ring	* Extent of laryngeal displacement at the moment of swallow	Tactual + visual	3 = detectable (visual + tactual) 2 = minimal laryngeal elevation. 1 = no detectable laryngeal elevation.

and little finger in the region of thyroid cartilage((Fig.7 Appendix A)			
*Masseter contraction- Masseter was palpated. placing index finger in the regionof masseter muscle (Fig.7 Appendix A)	* Degree of masaetSs contraction	Tactual + visual indication if any.	3 = present 2 = weak 1 = absent masseter contraction
*Circumoral tension - lips were separated using the thumb to observe for circum oral tension during the act of swallowing (Fig.7 Appendix A)	* Degree of tension based on the amount of pressure required in parting the lips at the moment of swallowing.	Kinesthetic + visual supplementation.	3 = negligible circumoraltension with extreme ease in labial parting. 2 = minimal tension, with slight difficulty in parting the lips. 1 = marked tension with extreme difficulty to inability in labial parting to no tension owing to flabby. lip musculature.
*Lingual position During the testing for circumoral tension together with	* Positioning of tongue in relation to other structures	Visual	3 = not visually evident. 2 = placed immediately behind incisors or between the dentition without

laryngeal elevation and masseter contraction, tongue position was noted.			food spillage. 1 =* placed between the dentition with food spillage.

The above 5 parameters of swallowing were tested as per the directions in testing for tongue thrust provided by Fletcher, Casteel and Bradley (1961).

*Mandibular stability - Mandibular displacement was noted with the middle finger placed beneath the mandible during swallowing.	* Extent of mandibular displacement.	Tactual + visual	3 * no detectable mandibular displacement (with only muscular movement in the sub–mandibular region) 2 = Slight mandibular displacement. 1 = marked mandibular displacement.
*Gulp	* Presence/absence and the amount of solid . for which gulp was obtained was noted.	Audition	The pattern obtained was noted. No rating was adopted.
*Post-swallow intraoral examination - Immediate post-swallow. - One minute after swallow.	* Full-meal or piece-meal swallow (for limited food material) * Presence and location of residual material post-swallow.	Visual, aided with tongue depressor	3 = clear, with no residual food in the oral cavity – full-meal swallow. 2 = Minimal residue (full-meal swallow). 1 = Marked residue/piece-meal swallow for the limited quantity of food provided.

Table-7: Evaluation of deglutition - drinking: simulated interrupted condition

Deglution act	Testing procedure	Pertinent observations	Observation modality	Rating scale adopted
Imbibition *Through pouted and unpouted glass	Both pouted and unpouted glass filled with 60 ml of water was brought close to the clients lips by the tester and the client was required to drink the eater Provided. Subject was seated in the normal eating posture of slightly forward bent position (about 80-85° with respect to the horizontal plane)	* Position of the glass	Visual	3 = rim of the glass placed between the lips. 2 = rim of the glass placed between lips and teeth + on tongue. 1 = rim of the glass placed between teeth with lips parted or unable to imbibe.
		*Degree of lip protrusion	Visual	3 = no protrusion 2 = minimal protrusion 1 = marked protrusion or no protrusion owing to restricted Labial mobility.
		* Cheek indrawing	Visual	3 = no cheek indrawing 2 = minimal cheek indrawing 1 = marked chee k indrawing or no cheek indrawing owing to restricted bucco labial mobility.
		* Additional features like tongue thrusting, biting moements etc. were looked for.		

00

		* Amount of water consumed In 3 trials (in ml) was noted.		This was quantitatively analysed.
*Through straw - -Standard cello-phane straw -Staaws of diameter 1.3cm and 1.8cm pf the same length as the standard straw.	Standard straw was placed at an angle of 45* with respect to horizontal* (based on pilot data), in the subject's mouth* permitting self manipulation. Client was instructed to draw in water.In presence of strong bite, an in-compressible plastic straw of the same dimension as the standard straw was used.	* Position of stzaw & degree of lip closure was noted. Clients report on straw placement was also noted whenever possible.	Visual	Position 3 = between lips 2 = between lips and teeth. 1 = between teeth with lips parted. Degree of lip closure: 3 = no labial tension 2 = minimal tension 1 = marked labial closure or in pathological condition, no tension in presence of flabby lips
		-		
	For the larger diameter straws angle with respect to horizontal was varied from vertical to horizontal till a marked ease in-flow with increase in speed and decrease in physical effect was enunciated.	* Angle at which ease of sucking was anunciated was noted. * Tongue thrust if present during the continuous sucking act was noted (which was exaggerated using the wide mouthed straw)	Visual	The data was quantitatively analyzed.

Swallowing	* Anterior seal- lips were parted to check whether anterior seal was labial/lin- qua dental or lingua alveolar/ with head tilted downward to check lingua seal ade- quacy with forced lip parting.	* Lingual/Labial seal. Adequacy of lin- qual seal(anter- ior implicated by liquid expre- ssion outside the oral cavity) was noted toget- her with the amount of liquid (in ml) sustained without leakage	Visual	3 = adequate seal 2 = minimal fluid leakage 1 = absent to inadequate lingus dental/alveolar seal with fluid loss.
	Amount of water in ml for which anterior seal could be obta- ined was noted. This was tested by presentation of graded quan- tity of water from 20 ml.. decreasing in 5 ml steps till the quantity for which seal could be effectively obtained.			
	* Posterior seal subject was in- structed to main- tain lingua velar contact for 1 minute, sustaining	Adequacy of post erior seal impli- cated by liquid loss o± tetention was determined	Visual	3 = adequate seal 2 = minimal fluid leakage 1 = inadequate zeal with fluid loss.

20 ml of water (owing to ease of observation of liquid loss) with head tilted slightly backward	* Presence or absence --> of swallow reflex was noted.	Visual under ade quate illumina-tion	3 = present (normal) 2 = weaK 1 = absent.
Swallow reflex This was tested with head held straight and mouth open. Water was directed into the oral cavity using a standard cellophane straw held horizontally by releasing the thumb at the other end of the straw.			
Laryngeal eleva-tion was observed placing the ring and little finger in the region of thyroid cartilage	* Extent of laryn-geal displacement	Tactual + visual	3 = detectable 2 = minimal laryngeal elevation. 1 = no detectable laryn-geal elevation.
Masseter contrac-tion-Masseter was placing the index finger in the region of masseter muscle		Tactual	The pattern obtained was noted. & scoring as in solids.)
Circumoral tension-lips were separa ted using the	* Degree of tension based on difficulty in labial parking	Kinesthetic + visual supplemen-tation	3 = negligible, with ex-treme ease in labial 2 = minimal tension, with

thumb to observe, for the degree of circum oral tension.			slight difficulty in parting the lips. 1= Marked tension to inability in parting the lips.
* Lingual positioning - tongue position during testing for circum oral tension was noted.	* Positioning of tongue in relation to other structures	Visual	3 = Not visually evident 2 = Placed immediately behind incisors, or between the dentition without food spillage. 1 = Placed between the dentition with food spillage.
* Mandibular stability - displacement was noted with middle finger placed beneath the mandible during swallowing.	* Extent of mandibular displacement.	Tactual + visual	3 = no detectable mandibular displacement with sub-mandibular muscle movememt being present. . 2 = slight mandibular displacement. 1 = marked mandibular displacement.
*Gulp: Minimum quantity of water (in ml) required to elicit an audible gulp was noted.	* Presence/absence of gulp	Audition	Only the pattern of response was noted. No rating scale was applied.

Repeat testing of all of the above subtests of deglutition - eating and drinking was done a minimum of three times to typify the pattern(s) of bolus manipulation adopted by the client accurately. This testing was randomized within the session. Individual session lasted between 20-45 minutes depending on the sample group. The oral behaviour thus evaluated was recorded in the response sheet and transcribed into the rating scale developed for this purpose for further analyses.

Reliability check: The entire test battery was readministered to 5 randomly chosen subjects -- 2 normal children, 2 normal adults and 1 cerebral palsied after a gap of one month to check for the test-retest-reliability. The scores were found to be reliable as they were identical for all the subjects in all the parameters of deglutition. No attempt was mad* to check on inter-rater reliability.

ANALYSIS. RESULTS AND DISCUSSION

The data on the different parameters of speech and deglutition were subjected to suitable statistical analyses whereever applicable and the findings discussed under four major sections:

I. Deglutition patterns in normal children and adults:
   1. Of solids
   2. Of liquids.

II. Deglutition patterns in spastic cerebral palsied.

III. Relationship between speech and deglutition:
   1. Articulation vs. oral phase of deglutition
   2. Voice vs. oral - pharyngeal phase of deglutition.

IV. Comparison of deglutition of normals and spastics based on the developmental data.

I. Deglutition patterns in normals:

1. Deglutition of solids: The different parameters of deglutition of solids are discussed below under the sections of (1) Imbibition (2) Mastication (3) Swallowing. The individual scores of the 47 normals is furnished in Table-8 (Appendix-B)

Imbibition:

Oral structure(s) employed in spoon clearance: From figure 9a, it can be noted that majority of the children upto 5-6 years of age employ dentition together with labial pursing to clear the food material off the spoon. From the age of 6 years onwards, the scores plateau to the adult value of 3, implicating labial usagefor spoon clearance. This may reflect maturational effect together with the sophistication secondary to social demands.

Efficiency: Efficiency of imbibition was found to be good at all the age groups studied with minimal variations in the score being attributed to individual variations. (Fig.9b).

Mastication: -

Biting: - Mature, adequate biting at voluntary level was seen at all the age groups studied with a maximum score of 3. Transition from reflexive level to this stage with the eruption of dentition requires further investigation (Fig.9c).

Chewing sound:- This shows a developmental trend with decrease in sound while chewing up the age scale (Fig.9d). The chewing sound here refers to that made by the lingual/labial/dental contacts in pulverization of soft food (here rice). The drop in score at the adult level may be attributed to the sample chosen. This parameter is dependent on the table manners, and socio-cultural variations. In lieu of the almost homogenous population in terms of the socio economic status, this may implicate social demands.

Labial movements accompanying chewing: This as seen in fig.9e. shows a developmental trend with a tendency to open mouth chewing in the lower age groups, the scores gradually increasing upto the age of 7 years (implying increase in closed mouth shewing) after which there is a plateau to a score of 2.8. This again implicates individual variations in the upper end of the age scale with majority exhibiting closed mouth, and minority open mouth chewing. This is subject to the anatomophysiological variation cum the social demands.

Detection of food position:- This, as depicted in fig.9f implicates a developmental trend. Children between age group 2-4 years exhibit relative ease of detection of food position on visual inspection, the indication being via open mouth, bucco labial tension + cheek bulging. Children in the age range 4-5 years show relatively lesser ease in location of food position from external clues indicated by minimal cheek bulge, minimal labial pursing + via open mouth. Clients above 5 years show a plateau in score of 3, implicative of difficulty in detection to very minimal labial pursing to retraction on the food side during the masticatory phase. This may be attributed to the physiological variation of marked tongue thrust and open mouth chewing in children upto 4 years of age, above which, the increase in score may implicate socially conditioned sophistication. The drop in scores to a value of 2.2 in age range 7-8 years implicates individual variation (socio-culturally in 2 clients with a score of one each).

Spillage:- This shows a developmental trend, as depicted by fig.9g, with minimal spillage being present between the age range 2-4 years above which it plateaus off to a score of 3 with spillage being absent. This is reflective of the anatomo-physiological variation and better neuromuscular coordination above 4 years of age. The greater space available for bolus maneuvering with increase in age aa suggested by Mason and proffit (1974), decrease in open mouth chewing and lesser degree of tongue thrust in the latter group may account for the reduced spillage.

Mode of labial clearance during chewing: As seen from figure 9h, it can be noted that between the age group 2-6 years, children make use of hand/finger together with lip vs denti-tion maneuver $\pm$ tongue protrusion to clear the material from the labial surface. Those between 5-7 years adopt lip vs. teeth maneuver $\pm$ tongue protrusion, and above 7 years of age, the scores show a plateau with minor individual varia-tions implicating labial pursing + minimal lingual protrusion with occasional hand usage. This is ^? conditioned socio-culturally* implicating the trend of increasing scores tqjbe a mark of sophistication.

Mandibular are traversed:- From Hig.9i, it can be noted that there is no variation in the pattern of mandibular are traversed across the age range from 2 years to adult group, implying maturation in chewing prior to 2 years of age. Investigation regarding this aspects below 2 years of age is implicated in lieu of transition from biting at a reflexive to mature volitional chewing pattern. The mature pattern here implicates consistent/inconsistent rotatory or side to side movement.

Range of movements:- From fig.9j, it can be noted that the range of movement in chewing the solids (rusk + chocolate) is exaggerated together with increase in the force of masseter contraction in clients upto 6 years of age. Above 6 years to the adult group, the scores tend to plateau with minimal variation, exhibiting relative decrease in the range of mandibular movement with increase in masseter force. This is reflective of socially conditioned sophistication.

Accompanying lingual movements and food placement:- Fig.9k, & 1 reflect the finding that children between 2-3 years exhibit marked lingual protrusion, with or without dissociation from jaw movement. Between 3-5 years, the incidence of lingual protrusion is relatively less,the scores tending to plateau at 5 years of age with no visually significant lingual movement during the act of chewing. This coincides with the placement of food, majority being anteriorly placed (close to incisors), tending to be lateralized and centralized in the age group above 5 years. This is reflective of the available space in the oral cavity for oral maneuvering and the effect of the erupting dentition.

Masseter contraction/force generated:- Fig.9m implicates plateauing in scores right from the lower limits of the age group studied. The minimal variations in age range 2-3 years may reflect the relative difficulty in detection of masseter contraction owing to the increase in adipose tissue in the buccal region and that in the age group 5-6 years may implicate individual variation in score, possibly reflecting physiological efficiency (maximum effect with minimal effort).

Chewing efficiency:- Fig.9n indicates that the pattern of chewing efficiency in normals is not predictable with scores ranging from 2v6 to 2.8-3 implying fair with small food particles to good, with well pulverized bolus. This is individually conditioned. An objective data based on the size of the particle could be a better indicator of efficiency in lieu of this finding. This in turn may reflect on the swallowing efficiency in normals,reflected by absence or minimal presence of residue on immediate post swallow intraoral examination.

Swallowing:

Cohesive bolus formation:- Fig.9.0 reflects a developmental trend regarding the ability to form cohesive bolus, showing a greater efficiency with increasing age. The data reveals a tendency to swallow with bolus spread out in the oral cavity, but majority being located in the centre (on the tongue and coated oa plate) in the age group 2-4 years. Between the age group 4-8 years, majority exhibited a cohesive Bolus with minimal spreading around the pit formed about 1 cm from the tongue tip. Those above the age of 8 years tended to form cohesive bolus with well defined margin, though there were minimal deviations from the pattern in the adult group. The shape of the cohesive bolus-oval,circular, kidney shaped was reflective of the anterior, posterior and lateral lingual forces employed.

Laryngeal elevation:- Fig.9p indicates that developmentally there is no predictable pattern of laryngeal displacement at the moment of swallow* The minimal variations from score 3 can be attributed to individual variations. Out of 6 clients (of the 47 normals studied) exhibiting weak laryngeal elevation, 4 were found to have weak masseter contraction with abnormal lingual positioning (either interdental or pressurization against dentition). One client had weak masseter contraction, but with normal circumoral tension and lingua alveolar contact at the moment of swallow. The other client with weak laryngeal elevation exhibited normal maaseter contraction, marked circumoral tension and abnormal lingual positioning. The above findings suggest, a plausible connection with the'tongue thrust syndrome', as also suggested by Palmer (l962).

Masseter contraction:- From Fig.9q, masseter contraction in the deglutition of solids is implicated (unlike in liquids discussed in section 12 on Deglutition of liquids). No particular pattern across the age range is evident. The deviations in score from the maximum value of 3 implicate weak masseter contraction, which is found to coincide with the presence of tongue thrust (as also suggested by Palmer, 1962).

Circumoral tension:- From Fig.9r it can be interpreted that circumoral tension is more in the age group 2-4 years. This may be reflective of the effort employed in minimizing spillage in presence of tongue thrust swallow. The scores show a plateauing from 4 to 8 years of age after which there is a drop in score which may be related to individual variations in lieu of tongue thrust.

Lingual positioning:- Fig.9s reflects the high incidence of tongue thrust in the normal population, showing no predictable developmental pattern. Table-9 provides the data regarding the distribution of lingual positioning as a function of circumoral tension for the 47 normals studied.

Table-9; Lingual positioning as a function of circumoral tention

Degree of circumoral tension	Lingual positioning		
	Normal	Abnormal	
		Interdental	Against dentition
Marked	2	15	1
Minimal	8	4	2
Normal	10	5	

The high coexistence of marked circumoral tension with abnormal lingual positioning may account for the reduced spillage in presence of tongue thrust and suggest the plausible role of anterior labial seal in cohesive bolus formation.

Spillage during swallowing: Developmental trend is noted here (Fig.9t) with minimal spillage seen in the lower age group between 2-3 years. This shows a plateau above 5 years of age. A drop in scores between 4-5 years may be attributed to individual variation. The findings coincide with the tongue thrust swallow in the lower age group, the sweeping anteroposterior lingual action between the dentition promoting spillage.

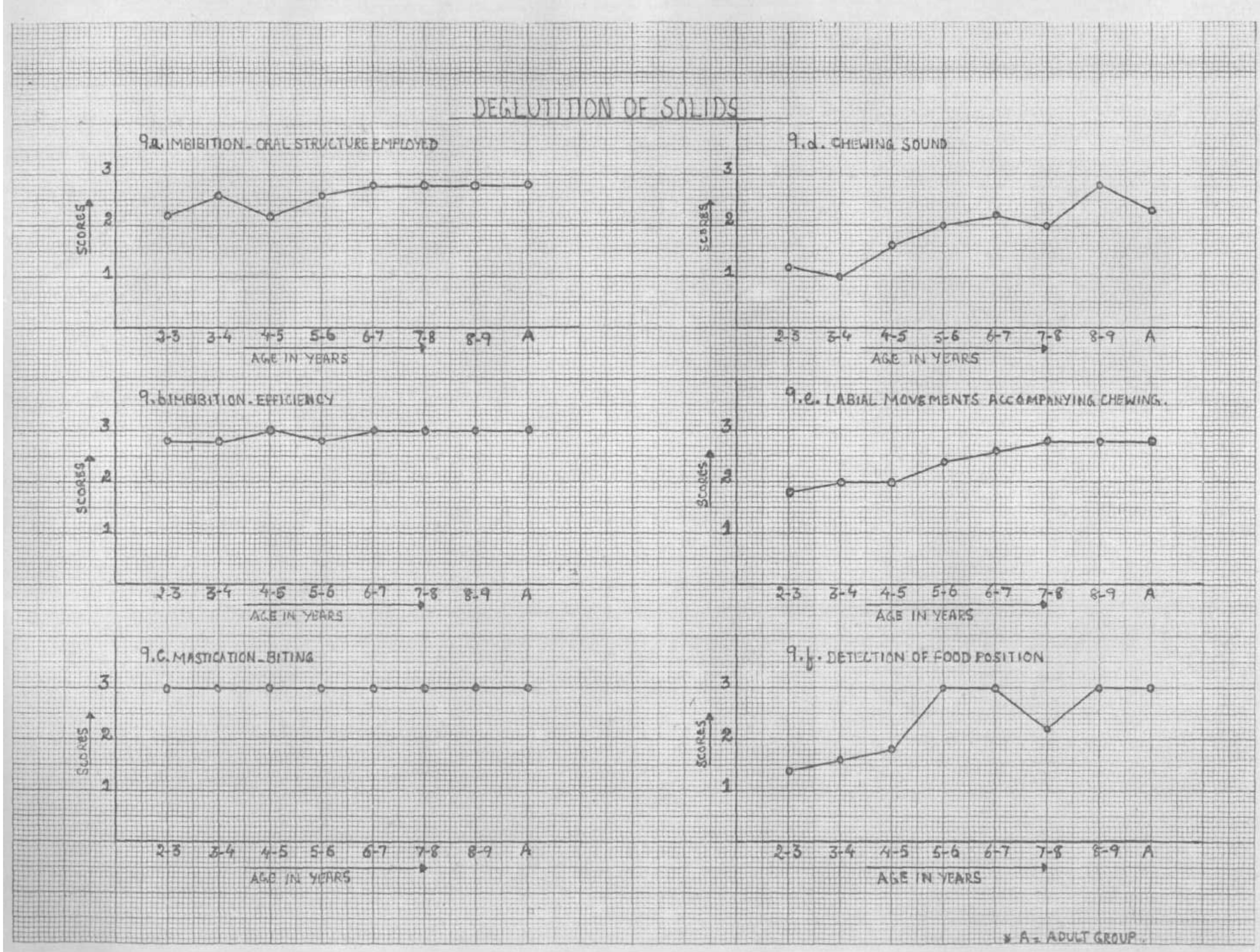
Mandibular stability:- Fig.9u indicates that mandibular stability, referring to the amount of mandibular displacement during swallowing increases with age. Children between 2-4 years show greater tendency for exaggerated mandibular displacement, with that between 4-6 exhibiting minimal mandibular displacement. In the age group above 6 years, greater mandibular stability, with only muscular movement and negligible jaw displacement is noted. This developmental trend may be implicative of maturation with lesser effort employed in swallowing.

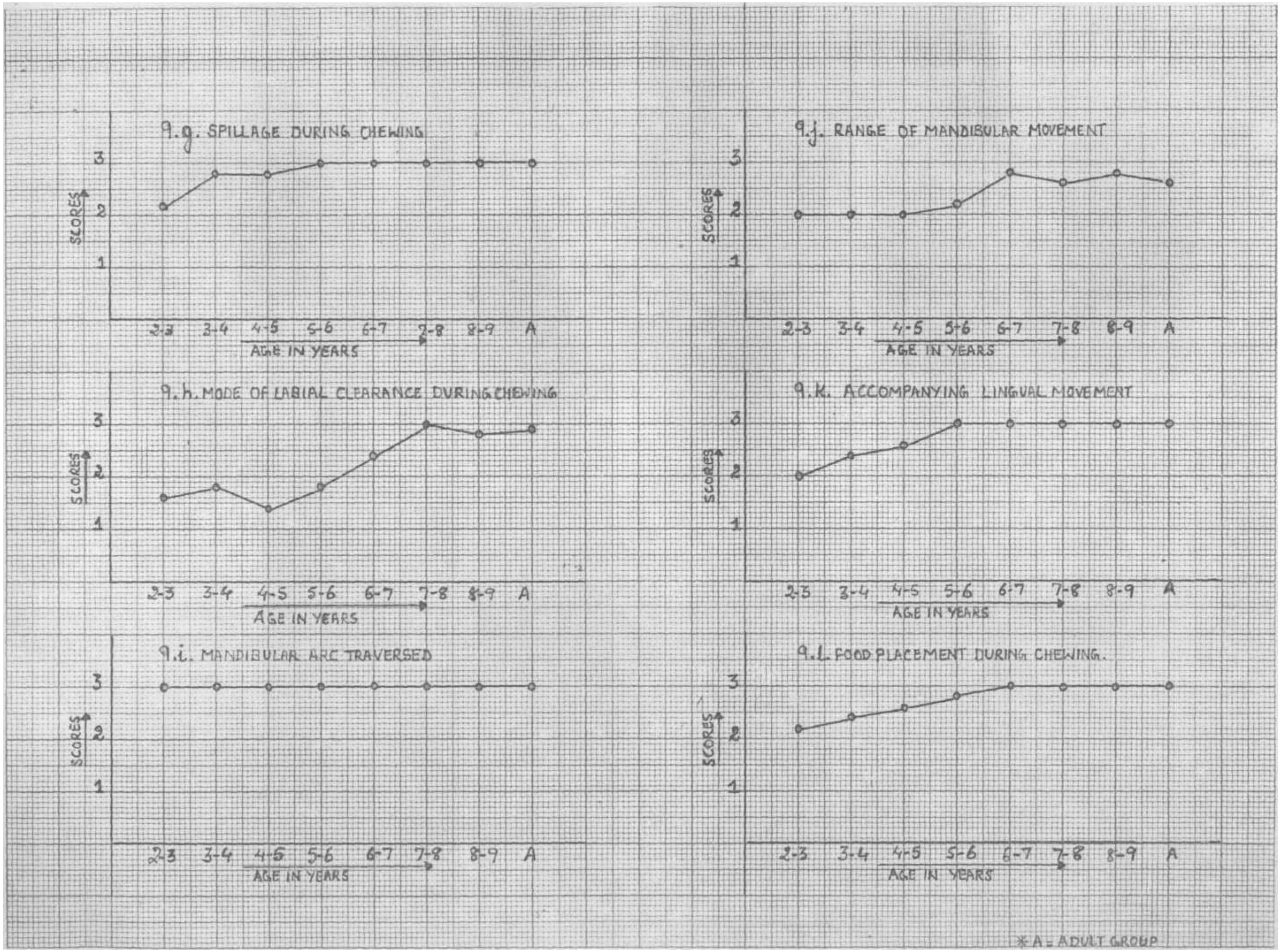
<u>Table-10</u>: 't' scores and significance of difference between means across age group for deglutition of solids.

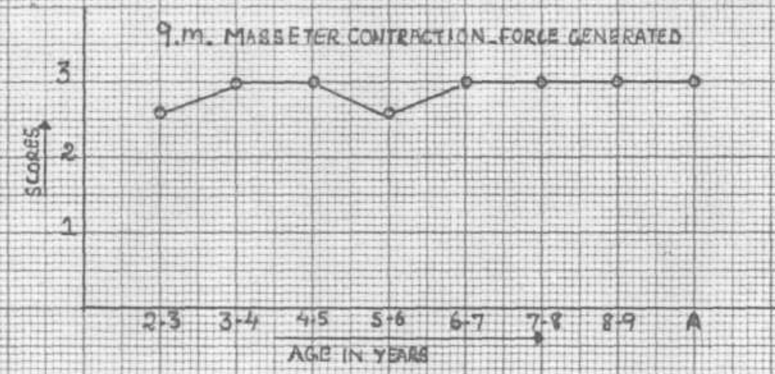
Age in years	2–3			3–4			4–5			5–6			6–7			7–8			8–9		
	Levels of significance																				
	t	0.05	0.01	t	0.05	0.01	t	0.05	0.01	t	0.05	0.01	t	0.05	0.01	t	0.05	0.01	t	0.05	0.01
2 - 3	-			1.64	NS	NS	3.96	S	S	6.93	S	S	12.21	S	S	6.40	S	S	11.49	S	S
3 - 4	1.64	NS	NS	-			2.43	S	NS	5.27	S	S	9.47	S	S	5.16	S	S	9.02	S	S
4 - 5	3.96	S	S	2.43	S	NS	-			1.61	NS	NS	2.22	NS	NS	3.05	S	NS	6.32	S	S
5 - 6	6.93	S	S	5.27	S	S	1.61	NS	NS	-			3.22	NS	NS	.99	NS	NS	2.26	NS	NS
6 - 7	12.21	S	S	9.47	S	S	2.22	NS	NS	2.22	NS	NS	-			0.22	NS	NS	0.56	NS	NS
7 - 8	6.40	S	S	5.16	S	S	3.05	S	NS	0.99	NS	NS	0.22	NS	NS	-			0.65	NS	NS
8 - 9	11.49	S	S	9.02	S	S	6.32	S	S	2.26	NS	NS	0.56	NS	NS	0.65	NS	NS	-		

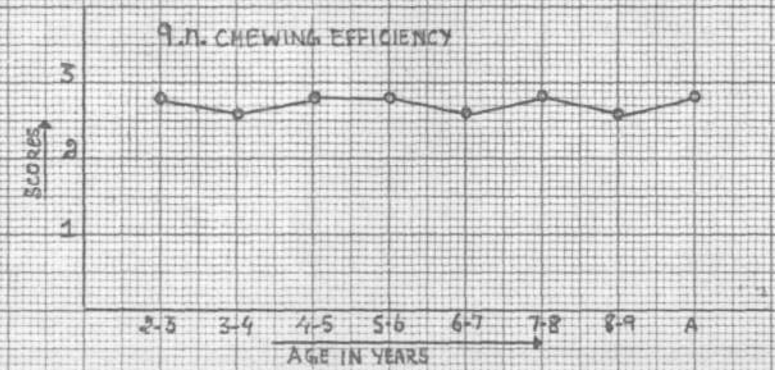
S = Significant at 0.05/0.01 level

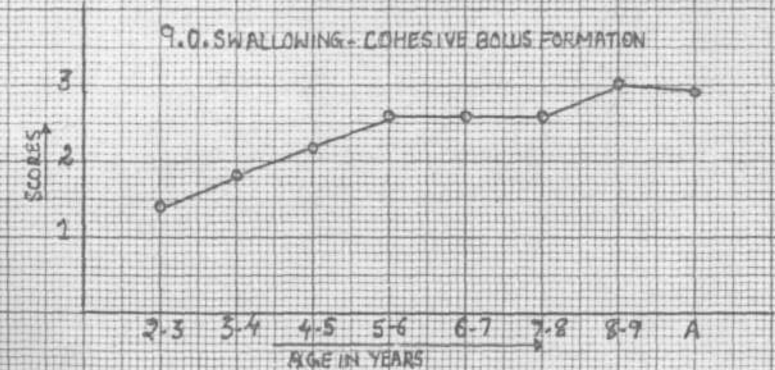
NS = Not significant at 0.05/0.01 level

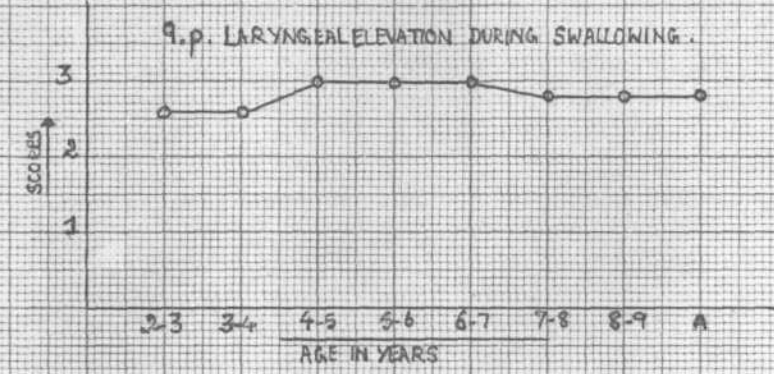

DEGLUTITION OF SOLIDS
9.a. IMBIBITION - ORAL STRUCTURE EMPLOYED
9.b. IMBIBITION - EFFICIENCY
9.c. MASTICATION - BITING
9.d. CHEWING SOUND
9.e. LABIAL MOVEMENTS ACCOMPANYING CHEWING.
9.f. DETECTION OF FOOD POSITION
SCORES
1
2
3
2-3
3-4
4-5
5-6
6-7
7-8
8-9
A
AGE IN YEARS
* A = ADULT GROUP.

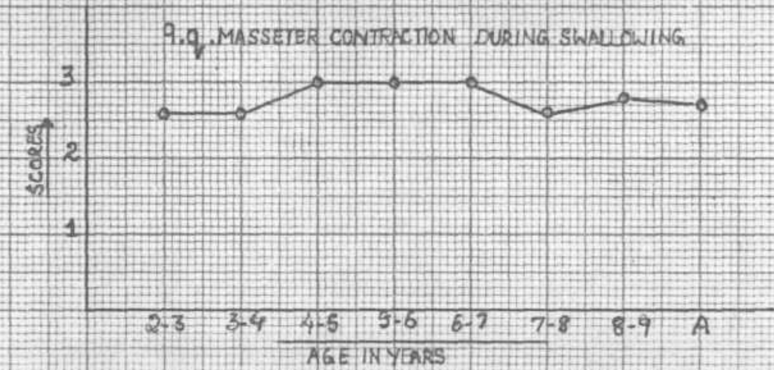

9.g. SPILLAGE DURING CHEWING
SCORES
AGE IN YEARS
9.h. MODE OF LABIAL CLEARANCE DURING CHEWING
SCORES
AGE IN YEARS
9.i. MANDIBULAR ARC TRAVERSED
SCORES
AGE IN YEARS
9.j. RANGE OF MANDIBULAR MOVEMENT
SCORES
AGE IN YEARS
9.k. ACCOMPANYING LINGUAL MOVEMENT
SCORES
AGE IN YEARS
9.l. FOOD PLACEMENT DURING CHEWING.
SCORES
AGE IN YEARS
2-3 3-4 4-5 5-6 6-7 7-8 8-9 A
* A = ADULT GROUP

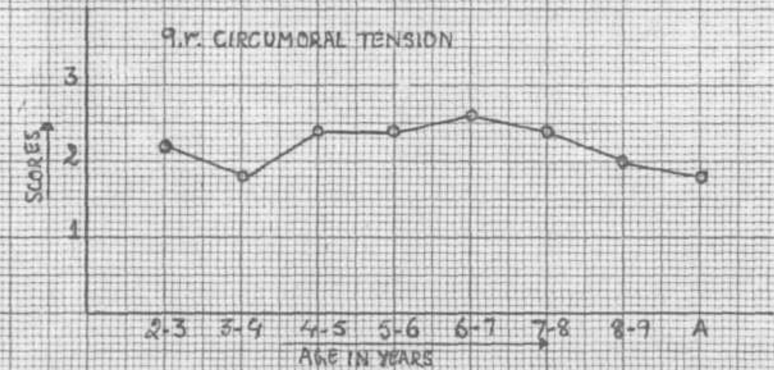




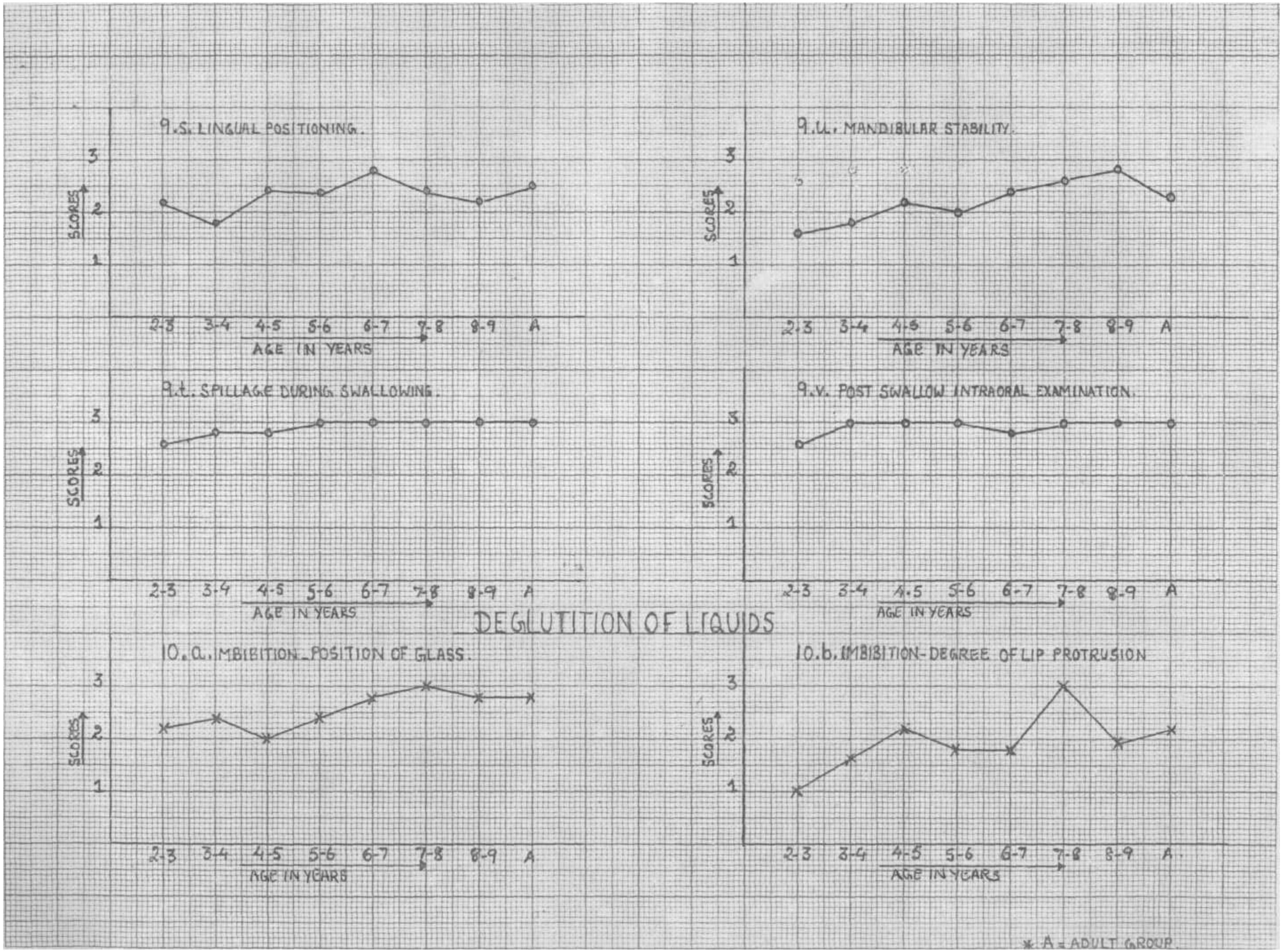


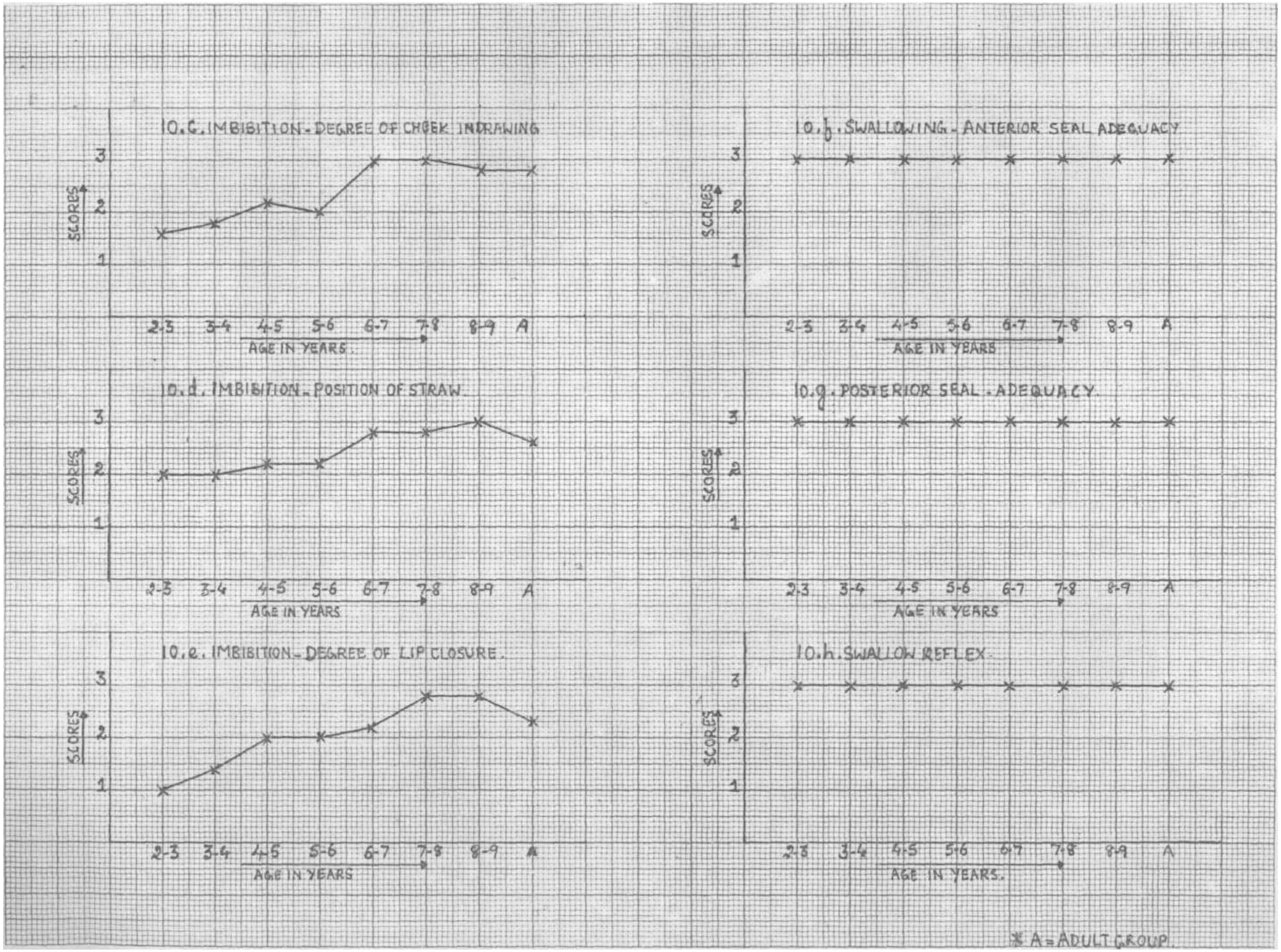




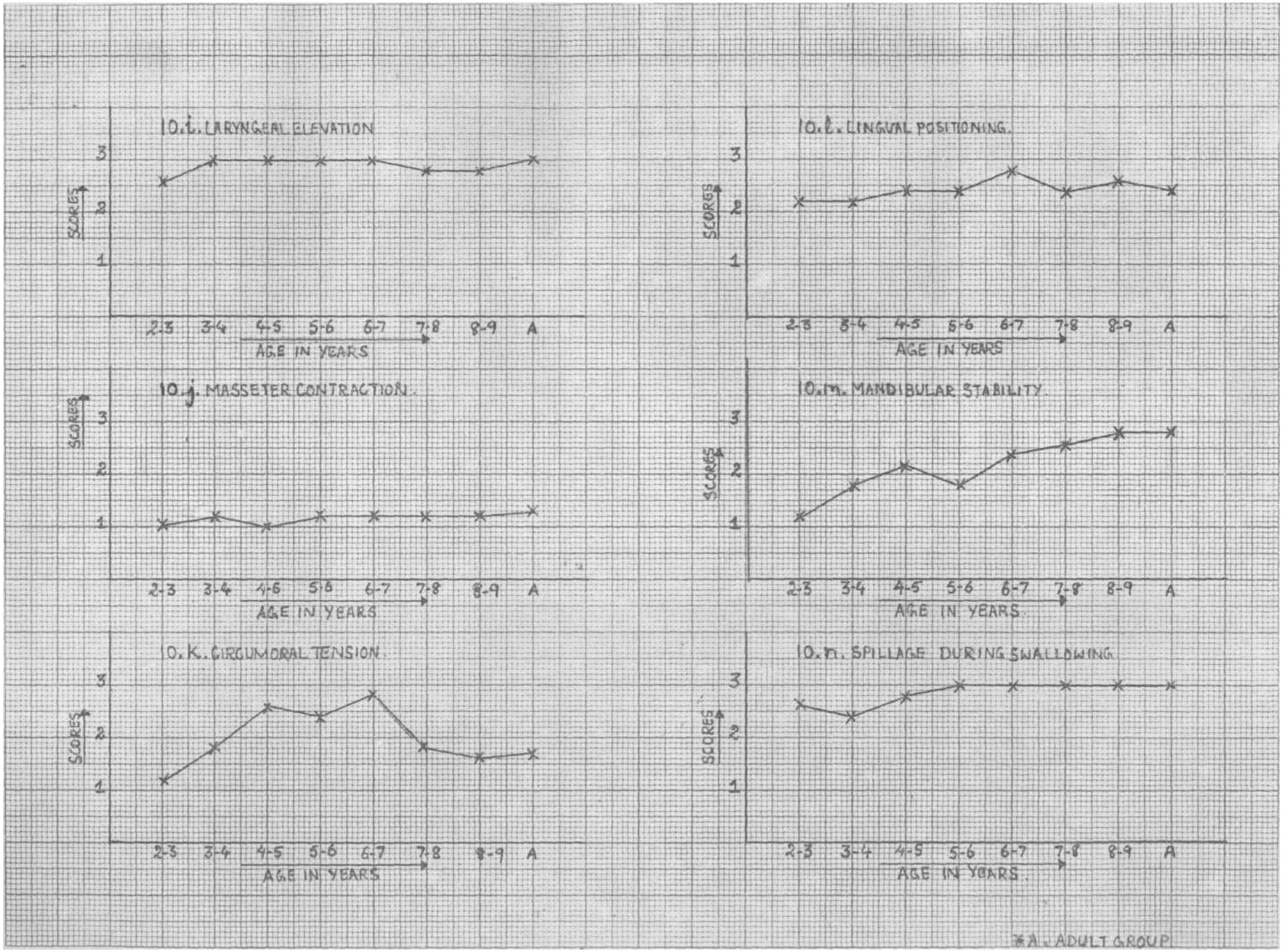


* A = ADULT GROUP


DEGLUTITION OF LIQUIDS
9.s. LINGUAL POSITIONING.
9.u. MANDIBULAR STABILITY.
9.t. SPILLAGE DURING SWALLOWING.
9.v. POST SWALLOW INTRAORAL EXAMINATION.
10.a. IMBIBITION_POSITION OF GLASS.
10.b. IMBIBITION-DEGREE OF LIP PROTRUSION
SCORES
1
2
3
2-3
3-4
4-5
5-6
6-7
7-8
8-9
A
AGE IN YEARS
* A = ADULT GROUP.



10.c. IMBIBITION - DEGREE OF CHEEK INDRAWING
10.d. IMBIBITION - POSITION OF STRAW.
10.e. IMBIBITION - DEGREE OF LIP CLOSURE.
10.f. SWALLOWING - ANTERIOR SEAL ADEQUACY
10.g. POSTERIOR SEAL - ADEQUACY.
10.h. SWALLOW REFLEX.
SCORES
1
2
3
2-3
3-4
4-5
5-6
6-7
7-8
8-9
A
AGE IN YEARS
* A = ADULT GROUP.


10.i. LARYNGEAL ELEVATION
10.j. MASSETER CONTRACTION.
10.K. CIRCUMORAL TENSION.
10.l. LINGUAL POSITIONING.
10.m. MANDIBULAR STABILITY.
10.n. SPILLAGE DURING SWALLOWING.
SCORES
3
2
1
2-3
3-4
4-5
5-6
6-7
7-8
8-9
A
AGE IN YEARS
*A. ADULT GROUP

1.2: <u>Deglutition of liquids</u>:

These are discussed under the sections of (l) Imbibition (2) Swallowing. Individual scores of the 47 normals for different parameters of deglutition of liquids is furnished in table-11 (Appendix-B)

<u>Imbibition</u>:

<u>Position of glass</u>: Prom fig.10 a, it can be noted that positioning of the glass follows a developmental trend, with majority of children in age groups 2-6 years tending towards placement of both pouted and unpouted glass over the labium and dentition. Majority of clients above the age group of 6 years tend towards placement of glass between the labium which may reflect socially conditionned sophistication.

<u>Degree of lip protrusion</u>: Fig.10 b, reflects the increased efficiency of sucking and sophistication in the pattern adopted for drinking both with straw and glass, with the lower age groups exhibiting marked labial protrusion, through minimal to negligible lip protrusion above the age group 7-6 years. The drop in scores for age group 8-9 and adults can be attributed to individual variations.

<u>Degree of cheek in drawing</u>:- This, as seen in fig. 10 c depicts a developmental trend, with majority in the age group 2-3, and

3-4 exhibiting marked cheek in-drawing during sucking. Majority of clients in 4-6 years age group exhibited minimal in-drawing of cheecks. The performance plateaued from the age group 6-7 onwards, exhibiting adult performance. This may be reflective of the reduced effort demanded in sucking (increased efficiency) and sophistication being reflective of the social demands.

Positioning of straw:- As seen in fig. 10d, children of the lower age group have a tendency to place the straw between lips and teeth, with majority above 6 years of age exhibiting labial placement. The minor variations in scores above this age group can be attributed to individual differences. This may be reflective of the degree of aophistication of the client.

Degree of lip closure:- From fig. 10.e it can be noted that children of the age group 2-4 years employ greater lip closure, the pressure tending to be relatively less in age group 4-7 years, plateauing to the non-tongue thrusting adult value with minimal labial pursing in sucking/sipping through straw. The reduction in scores in the adult tongue thrusters could be related to the increased circum oral tension during the act of swallowing. This developmental trend is implicative of the relative ease in sucking and the sophistication exhibited by the adults secondary to social demands.

Swallowing:

Anterior seal: As seen in Fig.lOf, adequacy of anterior seal is implicated right from the age group of 2-3 years reflecting its importance in swallow behaviour. The anterior seals noted were either lingua-interdental, lingua dental (against dentition) or lingua alveolar. The quantitative data on the amount of water sustained by the anterior seal is discussed in relation to tongue trust in the section on 'quantitative analysis of anterior seal'.

Posterior seal: Adequacy of posterior seal from the age group 2-3 years onwards is depicted in Fig.10g. This, as in the above reflects its importance in formation of the cohesive bolus and the peristaltic lingual movement to direct the bolus the the oropharynx.

Laryngeal elevation: Laryngeal elevation was found to plateau right at the lower age group. The minimal variations from the score 3 can be attributed to individual variations. The data may be interpreted on the same lines as in solids (Fig.10h).

Masseter contraction: Masseter contraction for liquids was found to be absent or weak in all the subjects studied, implicating the difference from solids in the force employed in swallowing (Fig.10 i).of the 8/47 clients with relatively strong masseter contraction (without masseter prominence) for solids,6 were found to have weak masseter contraction for liquids and the other 2 had no detectable masseter contraction. This information is of therapeutic value in that in training for swallowing, tactual clue be: provided when swallowing solids rather than liquids.

Circum oral tension: No predictable developmental pattern was noticed in terms of the degree of circum oral tension at the moment of swallowing as seen in fig. 10j. This was found to be more for the age group 2-4 years with majority exhibiting tongue thrust: nearly plateauing off from 4 to 7 years, with a drop in scores between 7-8 years which can be attributed to the effect of missing central incisor in CN 28 and 29 and slight open bite in CN 30. In the adult population, the reduction in scores can be attributed to the presence of tongue thrust.

Lingual positioning: From Fig.10k it can be noted that tongue thrust between the dentition is common upto the age of 6 years, which then reduces to the adult value of 2.8. The drop in scores at the age range 7-9 can be attributed to individual variations in the subject.

The current data can be viewed in light of Mason and proffi (1974) finding regarding posterior lingual placement with increase in age with provision of increased space to accommodate the tongue.

Mandibular stability: From Fig.101, it can be noted that mandibular stability/ here referring to the range the mandib le traverses during swallowing)increases with age, with 80% of children between 2-3 years exhibiting marked lowering and elevation, 80% between 3 to 6 years with mimimal jaw movement, 13.3% exhibiting marked depression, and elevation and 6.6% exhibiting negligible mandibular movement. Between 6-7 years of age, 60% of the clients exhibit minimal mandibular movement with 40% exhibiting no jaw movement, but only muscular movement tactually felt externally in the submandibular region. Between 7-8 years, 60% exhibited only muscular movement and 40% minimal jaw movement. In the age group of 8-9, 80% exhibited only muscular movement and 20% minimal jaw excursion; likewise in adults, 75% were found to have only muscular movement. This developmental trend may be suggestive of maturation, implying lesser effort in swallowing. This may also be socially conditioned.

Spillage during swallowing: Developmental trend is noticed here, with minimal spillage noticed at the lower age group between 2-4 years of age, Showing a plateau above 5 years. The drop in score between 4-5 years may be attributed to individual variation. This coincides with tongue thrust swallow in the lower age group, the sweeping antero-posterior action of the tongue between the dentition promoting spillage as also reported by Mason and Proffit (1974).

Significance

'f scores were calculated and the significance of difference between the two means across age groups for parameters of deglutition of liquids was computed at 0.05 and 0.01 levels, represented in table-12. This with/the findings in solids refutes the hypothesis that there is no difference in eating habits (oral and pharyngeal phases of deglutition) in normal children of different age groups and normal adults.

Quantitative analysis:

Table-13 furnishes the quantitative data of different parameters of deglutition of liquids in normals.

Placement of standard straw: Modal value of inclination with respect to the horizontal of the standard straw optimum for sucking as observed and reported by the subjects was found to be 45*, ranging from 45-60^0. Relative ease of enunciation of sucking was reported to be from vertical to horizontal positioning.

Placement of straw of internal diameter:1.3cm: No predictable pattern was seen in this aspect with the modal value being 45^0 /with respect to horizontal, range being 20* (for age range 2-3 years to 60^0. Ease of enunciation of sucking was noticeable from 35^0-85^0 (35 for CN1), with a modal value of 65^0,maximum concentration of scores being between 50^0-75^0.

Table-12: 't' scores and significance of difference between means across age grasp for deglutition of liquids.

Age in years / Age in years	2 - 3		3 - 4		4 - 5		5 - 6		6 - 7		7 - 8		8 - 9	
	Levels of significance													
	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01
2 - 3	-		3.49		4.15		5.38		11.00		14.6		9.05	
			S	S	S	S	S	S	S	S	S	S	S	S
3 - 4	3.49		-		1.41		1.54		4.80		2.98		4.19	
	S	S			NS	NS	NS	NS	S	S	S	NS	S	S
4 - 5	4.15		1.41		-		0.12		2.38		0.92		2.03	
	S	S	NS	NS			NS	NS	S	NS	NS	NS	NS	NS
5 - 6	5.38		1.54		0.12		-		2.61		0.92		2.16	
	S	S	NS	NS	NS	NS			S	NS	NS	NS	NS	NS
6 - 7	11		4.80		2.38		2.61		-		1.93		0.33	
	S	S	S	S	S	NS	S	NS			NS	NS	NS	NS
7 - 8	14.6		2.98		0.92		0.92		1.93		-		1.46	
	S	S	S	NS	NS	NS	NS	NS	NS	NS			NS	NS
8 - 9	9.05		4.19		2.03		2.16		0.33		1.46		-	
	S	S	S	S	NS	NS	NS	NS	NS	NS	NS	NS		

S = Significant at 0.05/0.01 level

NS = Not significant at 0.05/0.01 level.

Placement of straw of internal diameter: 1.8cm As in the above, no predictable pattern across age group was noticed. The modal value for optimal (natural) placement was 45^0, ranging from 20^0 to 50^0. The case of enunciation had a modal value of 60^0, ranging from 30^0-80^0. In general, the scores of this group compared to that of straw of diameter 1.3cm was found to either coincide or be lower than the latter set of scores , Which goes with the laws of liquid motion mechanics in that the resistance is greater in the latter straw, zequiring greater application of pressure to suck.

Quantitative data on anterior seal formation: The data represented in table-14 implicates the plausible connection between age, the lingual placement at the moment of swallow and the amount of fluid sustained by the anterior seal. In general, a developmental trend was noticed, with the age group between 2-4 years being capable of sustaining only 5 ml, owing to the anatomical variation i.e. small size plus presence of interdental tongue thrust with marked circum-oral tension. In the age group 4-5 years, the reduced score of 5 and 10 ml. in 2 clients may be attributed to the minimal circum-oral tension. This could be implicative of the compensatory maneuver for the anatomophysiological variation adopted

<u>Table-14</u>: Quantitative data on the amount of liquids sustained by anterior seal as a function of age, extent of circum-oral tension (COT) and lingual placement.

* = number of clients.

Degree of COT	age in years						
	* 2 - 3 ml	*3 - 4ml	* 4 - 5ml	*5 - 6m1	* 6 - 7ml	* 7 - 8ml	* 8 - 9 m l
Marked	2 5 2 5 (inter-dental)	1 5 1 7 (inter-dental)		1 5 (diastema) + against denti-tion)		1 7 (openbite) t 5 (inter-dental)	1 5 1 5 v (inter-dental)
Minimal	1 5	2 5 (inter-dental)	1 5 (later with in-ter den-tal)	1 15	1 5	1 5 (inter-dental) 1 5 (absent central incisor)	2 5 1 10
Normal		1 5	3 15 (but 1 inter de-ntal)	1 5 (inter-dental) 2 15	2 5 1 10 1 10 (latter with openbite)	1 20	
Suggestive normative value	-	5 ml	15 ml	15 ml		20 ml	

by the lip taking an active role in formation of anterior seal and accounting for the reduced score in the amount of fluid sustainence. In the age group of 4-5 years, less than 15 ml. of fluid could be adequately sustained, which could be the normative score for this age group. The reduced scores in the age group 6-7 years in presence of normal circum oral tension could not be explained. Presence of diastema/absence of incisors was also found to reduce the score, with increase in circumoral tension (marked/minimal). Thence the amount of luid sustained by the 7-8 year age group is 20 ml. which could be the normative value. That for 8-9 years is not available since all the clients exhibited some amount of circum oral tension. In the female adult population, the modal value of amount of fluid sustained was 20 m6. ranging from 15-30 ml. with reduced scores in tongue thrusters. This in relation to oral cavity size requires further investigation, the male-female differences being evident from the pubertal period.

In light of the current findings of a plausible developmental trend, this requires further investigation in the adult population, which in the absence of mising teeth may predict the presence of tongue thrust.

Amount consumed in 3 trials: No predictable pattern was evident but in general, there was a trend towards increase in the amount of fluid intake per trial from age group 2-3/adults.

This can be accounted for on the basis of the antomical variation in size of the oral cavity, permitting retention of greater volumeof fluid in the larger cavity.

Gulp: Variability in the amount of fluid in ml at which gulp was auditorily detectable was noticed. In general, children in the age group 2-5 years had a modal value of 5 ml? from 5-7 years, 10 ml, 7-9 years; 5 ml, tongue thrusting adults,10 ml and non-tongue thrusters, 15 ml.

II. Deglutition in cerebral palsied:

The current section enlists the deglutition patterns in the 7 spastic CP studied, highlighting the deviances (primitive/pathological) or otherwise seen in the group. Table 8 and 11 (Appendix-B) provide the scores obtained for solids and liquids respectively. On the basis of extent of involvement of the oral motorium, total scores have been obtained for the 4 CP groups, viz.

(i) Minimal oral involvement (CPI)

(ii) Mild oral involvement (CP2 and 3)

(iii) Moderate oral involvement (CP 4, 6, 7)

(iv) Moderately severe oral involvement (CP 5)

depicted in table 15 and 16. The patterns involved have been furnished at length in table-17 and 18 (Appendix B).

Table-15: scores obtained on deglutition of solids and liquids for CP sample.

Parameters	CP-1 Minimal	CP-2 Mild	CP-3 Mild	CP-4 Moderate	CP-5 Moderately Severe	CP-6 Moderate	CP-7 Moderate
Solids							
Imbibition	6	5	5	4	2	6	5
Biting	3	3	3	2	2	3	3
Chewing	28	20	18	21	15	17	20
swallowing	18	16	16	12	11	9	12
Total	55	44	42	39	30	35	40
Liquids							
Imbibition	13	7	9	9	5	11	8
Swallowing	22	19	22	19	10	14	15
Total	35	26	31	28	15	25	23

Table-16: Total scores on deglutition for CP on the basis of degree of oral involvement.

Parameters	Degree of oral involvement			
	Minimal	Mild	Moderate	Moderately severe
Solids:				
Imbibition	6	5	5	2
Biting	3	3	2.7	2
Chewing	28	19	19.3	15
Swallowing	18	16.5	11	11
Total	55	43.5	38	30
Liquids:				
Imbibition	13	8	9.3	5
Swallowing	22	20.5	16	10
Total	35	28.5	25.3	15

History revealed a consistent finding of application of faulty feeding patterns including retension at soft food level for all but CP 1 and CP 7; food presentation being directed downwards promoting easy flow into the oral cavity without the need for active imbibition and head tilt as a mode of swallowing, also used in the reduction of sialorrhoea (drooling) as an accommodative reaction being further promoted by the parents.

The data on deglutition highlights that efficiency of oral pharyngeal deglutition ranges from near normal performance to moderately severe, the different parameters of deglutition of liquids and solids being differentially affected.

Primitive and pathological features in deglutition:seen in the 7 spastics:

Primitive features: This implicates the persistence of patterns of deglutition, lower in the developmental sequence (seen in the younger age groups) Eg. lingual fronting beyond the age group 2-4 years etc.

Pathological features: This includes the deviant features not seen in the developmental sequence, a sequelae of nervous system involvement. This features are discussed below in lieu of the different parameters deglutition involved.

1. Imbibition:

a) Inability to imbibe due to reduced tonicity of labial musculature (CP 5); also reported by Ward, Malone and Jann, 1964; Stark, 1985.

b) Tongue thrust pattern for sppon clearance (CP 4 and 5); also reported by Scherzer and Techarnuter, 1982y further exaggerated on drinking through straws of larger diameter.

c) Increased tension (labial) for spoon clearance (CP 7).

d) Bite reflex for straw (CP 4 and 5); as also reported by Scherzer and Tscharnuter, 1982; Stark, 19851

e) Imbibition with assistance from gravity seen in CP 5.

Despite the presence of clumsy labial movements, imbibition efficiency was good for solids,implicating the case of this act in the absence of marked labial involvement. Difficulty in sucking through the straws of thicker diameter as seen by near horizontal placement of straw to enunciate easy flow can be attributed to the following:

(i) Inability to purse the lips (CP-5) or inability to sustain lip closure (CP 7) (feature in CP, reported by Westlake and Rutherford 1961; McDonald and Chance, 1964; Hoberman and Hoberman, 1960.

(ii) Inadequate velopharyngeal closure (with minimal to hypernasality in all but CP 1 and CP 3), the 2 being related (Hetsell, 1969).

(iii) Weak swallow reflex in CP 5 and 7.

2. <u>Mastication</u>:

<u>Biting</u>: - This was found to be efficient in 5 out of 7 cases studied. The pathological features noted were weak bite in CP 4 and 5. This was found to be related to the weak masseter contraction noted in the two subjects.

<u>Chewing</u>:

(i) **<u>Accompanying labial movement</u>:** Clumsy labial movements in the category with moderate oral involvement was a noticeable feature. In CP 5 of moderately severe involvement, this feature was not noted, attributable to the restricted labial mobility and reduced muscular tonicity.

(ii) **<u>Spillage</u>:** In the mild, moderate and moderately severe categories, spillage was a noticeable feature, attributable to the anterior placement of food, lingual fronting (a primitive feature) also reported by Hardy, 1983; and labial involvement, especially in CP 5 and 7; the latter presenting with excessive habitualized mouth opening (a feature in CP, reported by Crickmay, 1981)

(iii) **<u>Mandibular arc traversed</u>:** Pathological features included; (a) Jerky movements (CP 2, 4,7) (b) Jaw deviation to the side of greater spasticity(to right in CP 6) (c) Biting movement (CP 7) as also reported by Palmer, 1947; Circkmay, 1981; Scherzer and Tscharnuter, 1982.

(d) Typically slow mandibular movement (CP 1 through 7).

(iv) **Accompanying lingual movements:** Apart from the primitive feature of lingual fronting, the pathological features include, clumsy movement (CP 4, 7), inability to perform lingual maneuvering to shift the food to the grinding surface of the dentition (CP 6, 5).

(v) **Food placement:** Closely related to the lingual movement is the location of food during the act of chewing. Anterior placement was a consistent primitive feature. Food position on the side of relative greater Involvement (right) was seen in CP 6 which may be attributed to the relative ease of chewing with better and earlier occurrence of centric occlusion on the right side (jaw showing a consistent deviation to the right). Persistence of food placement in the manner presented to the client (eg. if placed on tongue/grinding surface of dentition by the clinician) implicates difficulty in lingual maneuvering, seen in CP 5 and6.

(vii) **Overall efficiency:** In the entire CP population, except the minimally involved, a general tendency, not noticed in the normal population studied, but a feature in edentulous geriatrics, viz. tendency to soften the hard food materials adoptation of lingua palatal preseurization maneuver (intra oral assisting aids) was observed. This coupled with the inability to perform lingual maneuvering to shift the food to grinding surface of the dentition brought about a fair to poor chewing efficiency with minimal pulverization of good items. This refutes Love et al's (1980) study who report that biting and swallowing offered almost no hazards to the majority. This could be attributed to the criteria adopted in labeling efficient pulverization of food, neglecting the intraoral compensatory maneuver adopted by the cerebral palsied in this task.

3. Swallowing:

(i) Cohesive bolus formation, anterior and posterior seal:

Inability to form a cohesive bolus in the'pit! about 1 cm. posterior to tongue tip implicateslingual involvement, in CP 1, 4, 5, and 7. The feature of minimal spreading around the bolus, ought to be considered in lieu of the age group. This is closely related to the ability to form anterior,posterior and lateral seals. The reduced fluid retention an anterior seal can be attributed to the lingual positioning (as discussed in the data on quantitative analysis of liquid retention on anterior seal).

Absence of lingua dental/alveolar/palatal anterior seal in CP 5 implicates restricted anterior tongue mobility. Weak posterior seal with leakage of fluid into the oropharynx is also a pathological feature (CP 5, 6) not seen in normals, implicating involvement of back of the tongue.

The coexistence of pressurization maneuver in chewing solids and absence of restricted/anterior tongue mobility in CP 5 can be attributed to the relatively better performance of back of the tongue, aiding in this function.

(ii) <u>Laryngeal elevation</u>: Weak/undetectable movement was a feature seen in 5 out of 7 cases. This, as in normals may be a feature associated with tongue thrust swallow. In CP 5 and 7, this implicates together with other features as in normals, a pathological phenomena with loding of food close to the larynx, with a resultant wet gurgling voice-post swallow.

(iii) <u>Masseter contraction</u>: Weak masseter contraction was found in all the 4 groups of CP, which may or may not be related to the tongue thrust syndrome. In swallowing liquids, as in normals; masseter contraction was absent except in CP 1 with masseter prominence which depicts a pathological feature in lieu of weak masseter contraction for solids.

(iv) <u>Circum oral tension</u>: Minimal to marked ciccum oral tension was noticed, which may or may not be related to tongue thrust syndrome. In CP 5, absence of circum oral tension is attributable to the lack of tonizity of the labial musculature,as also reflected in inability to perform the act of imbibition.

(v) <u>Lingual positioning</u>: Tongue thrusting was a noticeable feature in all the 4 groups atndied, with an antero posterior lingual movement at the instant of swallowing in all but CP 4 with only anterior movement. This antero posterior movement is unlike that seen in normals above 4 years of age. Tongue thrusting in CP 2 could not be differentiated from that seen in the peer age group. The anteroposterior tongue movement with or without (as in CP 5) contact with the dentition may be a primitive pattern rather than pathological, in the absence of extensor thrust, yet, in lieu of the accompanying marked circumoral tension and presence of spillage, this may be considered as a pathological phenomena.

Phenomena of tongue thrust in the CP group has been reported by Hardy, 1983. This, according to Cleall, 1965 may be a resultant of disrupted tactile sensory control, which ought to be investigated in detail in the cerebral palsied.

(vi) <u>Spillage</u>: Spillage, secondary to tongue thrust swallow despite the presence of marked circumoral tension is a feature noticed in the mild and moderate category. Spillage, also a feature of the moderately severe category may be attributed to the anterior food placement, tongue thrust swallow and lack of adequate oral closure at the moment of swallow (Cp.5).

(vii) **Post swallow intra oral examination**: Presence of residual bolus one minute after swallow is a feature in moderate and moderately severe categories. The location of the residual bolus is suggestive of the corresponding oral structure involvement. For instance, stasis of bolus in lateral sulcus may imply reduced tension in buccal musculature; and restricted lingual mobility, inefficient to clear the material of the sulcus; in anterior sulcus, implicating reduced buccolabial tension; on tongue implicating reduced lingual mobility; sublingually, implicating reduced lingual maneuvering in directing bolus posteriorly; in pharyngeal wall implicating reduced and inefficient laryngeal reflex.

(viii) **Other feature**: Piecemeal swallow of the limited amount of food provided was a marked feature of the moderate and moderately severe group implicating the inability to handle large sized bolus effectively or fear of aspiration (as suggested by Logemann, 1986). Also, the maneuver adopted in swallowing solids by CP 6 simulating sucking movements with labial protrusion and cheeck indrawing; labial + lingua palatal clicking sound may indicate the persistence of primitive sucking patterns in swallowing solids, with no differential oral maneuvering (hence the differential scores in swallowing of solids and liquids).

<u>Assistive head tilt</u>: This was a consistent feature noted in all the 7 cerebral palsied which may be a compensatory mechanism in bolus manipulation and swallowing. This feature, in addition, may be reflective of the commonly adopted faulty therapeutic method to control drooling. This feature has been reported in CP population by Palmer, 1962; Mavirakere and Srivananthan, 1986.

The data on the amount of fluid consumed per intake cannot be interpreted at this juncture, warranting development of norms which may be of therapeutic value.

The above findings refute the 2nd hypothesis which states that There is no difference in the act of oral - pharyngeal deglutition in spastic cerebral palsied and normals.

III. Relationship between speech and deglutition in normals and spastics:

1. **Articulation versus deglutition**: The data on articulation of Kannada speech sounds in isolation and word level and different parameters of swallowing (liquids and solids) were compared to bring out the similarities or otherwise between the two motor acts. These included: -

(i) Position and adequacy of anterior seal at the moment of swallow versus articulatory placement in the production of lingua alveolars /t/,/d/,/n/ and /s/.

(ii) Position and adequacy of posterior seal versus production of velars/k/ and /g/

These are discussed, under two main headings of -

1) Articulation versus tongue thrust swallow.

2) Articulation versus non-tongue thrust awallow.

Table-19: Distribution of non-tongue thrust and tongue thrust swalow in children and adults.

N = 47 (35 children and 12 adults)

Non-tongue thrust swallow	Tongue thrust swallow
51% (24 subjects - 18 children and 6 adults)	48% (23 subjects - 17 children and 6 adults). 87% (16 children and 4 adults) had interdental lingual placement. 13% (1 child and 2 adults) had pressurization against dentition.

Articulation versus tongue-thrust swallow: Out of the 20 subjects (16 children and 4 adults) with lingual placement between the dentition information of the anterior seal during swallow, 90% (14 children and 4 adults) had perceptually normal articulation of /t/,/d/ and /n/ sounds with lingua dentol placement. However, among these, 35.7% (5 out of the 14 children) had distorted /s/ articulation with interdental lisp, falling in the age range 2-4 years. This ought to be considered in lieu of the developing phonology, /s/ articulation for the other 65% inclusive of 9 children and 4 adults out of the 90% (14 children and 9 adults) was lingua alveolar. The other 10% (2 children) had normal articulation of the sounds tested with lingua alveolar placement.

All the 13% of the subjects (2 adults and 1 child) with lingual pressurization against dentition during swallow, had normal articulation of /t//d/ and /n/ with place of articulation being against the dentition. 66.7% of them (2 adults) had lingua alveolar /s/ articulation and 33.3% (1 child) had distorted /s/. This could be attributed to the absence of left upper incisors.

Articulation versus non-tongue thrust swallow: Of the 24 subjects (l8 children and 6 adults) with lingua alveolar anterior seal, 83.3% (14 children and 6 adults) had perceptually normal articulation of /t/,/d/. /n/ and /s/ with lingua alveolar placement. Of the other 16.7% (4 children) CN 4 had distorted /s/ which could be attributed to age factor and presence of a large diastema between the central and lateral incisors. CN 6 had omission of /s/ which may be attributed to the developing phonology. CN 25 had an interdental lisp and CN 29 had auditorily normal articulation of the alveolar sounds but interdental placement (except for /s/).

All of the above had an adequate lingua velar posterior seal with correct articulation of the velar sounds /k/ and /g/.

Articulation versus swallow in C.P: 6 out of 7 cerebral palsied subjects studied had normal articulation of /t/,/d/, and /n/ with interdental lingual placement exhibiting adequate anterior seal in the simulated interrupted condition of deglutition and tongue thrust swallow with tongue in contact with the dentition. CP 1 with minimal oral involvement had normal /s/ articulation with lingua alveolar placement. CP 2, 3, 4, 6 and 7 (with mild and moderate involvement) had distortion of /s/ with interdental lisp. Additionally, in CP 6, weak lingua velar articulation of /k/ and /g/ was noted which was found to relate to minimal posterior seal leakage. In CP 7,lax articulation of /k/ and /g/ in the presence of adequate posterior seal was noted. Other clients exhibited normal to tense lingua velar production with adequate posterior seal.

Following articulatory errors were noticed in CP 5 in relation to deglutition;-

a) Inability to imbibe via straw/spoon was related to weak bilabial production /b/&/p/.

b) Omission of /t/,/n/,/d/ was found to relate to inability to form the anterior seal and presence of tongue thrust with no contact with the passive articulators (alveolus/dentition).

The above findings implicate the plausible relationship between the two motor acts of speech and deglutition, supporting that of Feltcher et al's (1961) study regarding the high incidence of tongue thrust in normal population and perceptually normal articulation of /t/,/d/,/n/ with interdental lingual placement. The sibilant distortion /s/ seen in the younger age group of 2-4 years with interdental lisp requires interpretation in lieu of the developing phonology. This follows the finding that increase in the oral pharyngeal size may account for the adaptation from tongue thrust swallow to a normal adult swallow (Mason and Proffit, 1974), same being the case with articulatory posture adopted in speech.

In lieu of similar findings in C.P. (high incidence of visceral swallow and interdental articulation), the data requires a differential interpretation even in the absence of extensor thrust. Due consideration ought to be given to the <u>type of tongue thrust</u> exhibited by the subject. Among the normal group with interdental tongue thrust anterior to posterior sweeping movement during swallow was found in the age group 2-3 and 3-4 years, like being the case with the cerebral palsied population. In interdental tongue thrusters above 4 years of age the tongue remained fixed at the interdental posture at the moment of swallow. Another interesting observation of relevance here is the presence of prominent rugae palatini in 12 out of 15 tongue thrusters (supporting Palmer's (1962) observation) only above 4 years of age. The like was not noticed in the cerebral palsied population except in CP 5 which was structurally similar to that seen in tongue thrusters. The non-prominent rugae in non-tongue thrusters may be attributed to theincreased pre-ssurization of tongue against the hard palate,a resultant of the high frequency of swallow and anterior consonant articulation in speech.Exaggerated plicae can be attributed to the difference in lingual placement during the two acts, this also being the case with CP 5 with absence of anterior lingual seal.

Also, the faulty therapeutic effect of interdental tongue placement cannot be ruled out in the cerebral palsy population.

Weak bilabial articulation and inability to imbibe using lips reflects the labial involvement in CP 5.

The coexistence of weak lingua velar articulation in 2 out of 3 cerebral palsied clients with inadequate posterior seal requires further probing with a larger sample to bring forth the relation, if any between the two motor acts.

2. Postswallow voice versus deglutition:

Table-20: Pre, post swalow and post cough/throat clearance voice evaluation of the 7 spastics.and normals

Client	Preswallow voice	Post swallow voice	Voice post cough/ throat clearance
Normals	Normal	Normal	Normal
CP 1,2, 3,4,6	Normal	Normal	Normal
CP 5	Normal	Wet gurgle	Normal
CP 7	Hoarse, wet gurgle	Hoarse, wet gurgle.	Normal

The above data implicates a close coordination between voice and pharyngeal phase of deglutition in normals and CP 1, 2, 3, 4 and 6. In CP 5,wet gargling voice was marked immediately after swallow. Preswallow voice of CP 7 was found to be hoarse with wet gurgling component. Employment of a second swallow technique (of swallowing saliva) or voluntary cough or throat clearance normalized the voice. Voice, post swallow of the bolus was found to resume the wet gurgling quality implying bolus stasis close to the vocal cords.

In lieu of these findings, the following reasons may be speculated which were consistent in both the subjects (CP 5 and CP 7).

(i) Weak swallow reflex

(ii) Weak laryngeal elevation

(iii) Coating of the food material on the posterior pharyngeal wall.

(iv) Swallow being elicited without cohesive bolus formation which may promote spillage close to the laryngeal inlet.

(v) Piecemeal deglutition (even for small quantity-of food) which may be suggestive of, apart from inability to handle large bolus, the fear of aspiration.

The above data on articulation and voice in relation to deglutition implicate the close relationship between the 2 motor acts refuting hypothesis 3 which states that 'There is no relationship between the motor act of deglutition and speech.

IV. Comparison of spastic CP and normals on deglutition of solids and liquids:

Figure 11 represents the performance of normals and spastics on different parameters of deglutition of solids (imbibition, mastication and swallowing)and liquids (imbibition and swallowing). Individual performance of the spastics with reference to the peer scores is discussed below:

Minimal involvement:

CP 1: Age 9.7 years:

Deglutition of solids: Scores on imbibition is in par with the

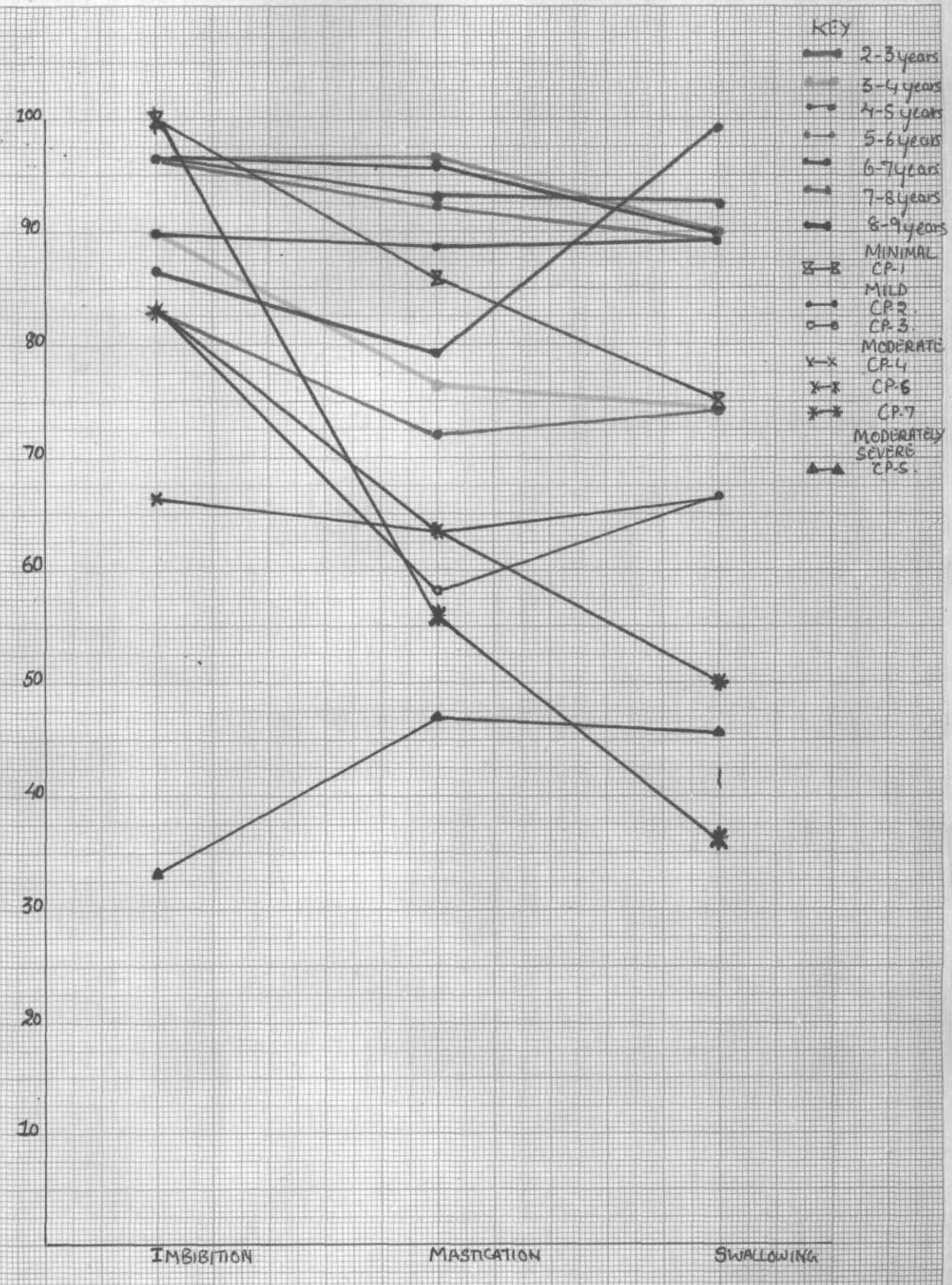


FIG.11a. Deglutition of solids in normals and spastics

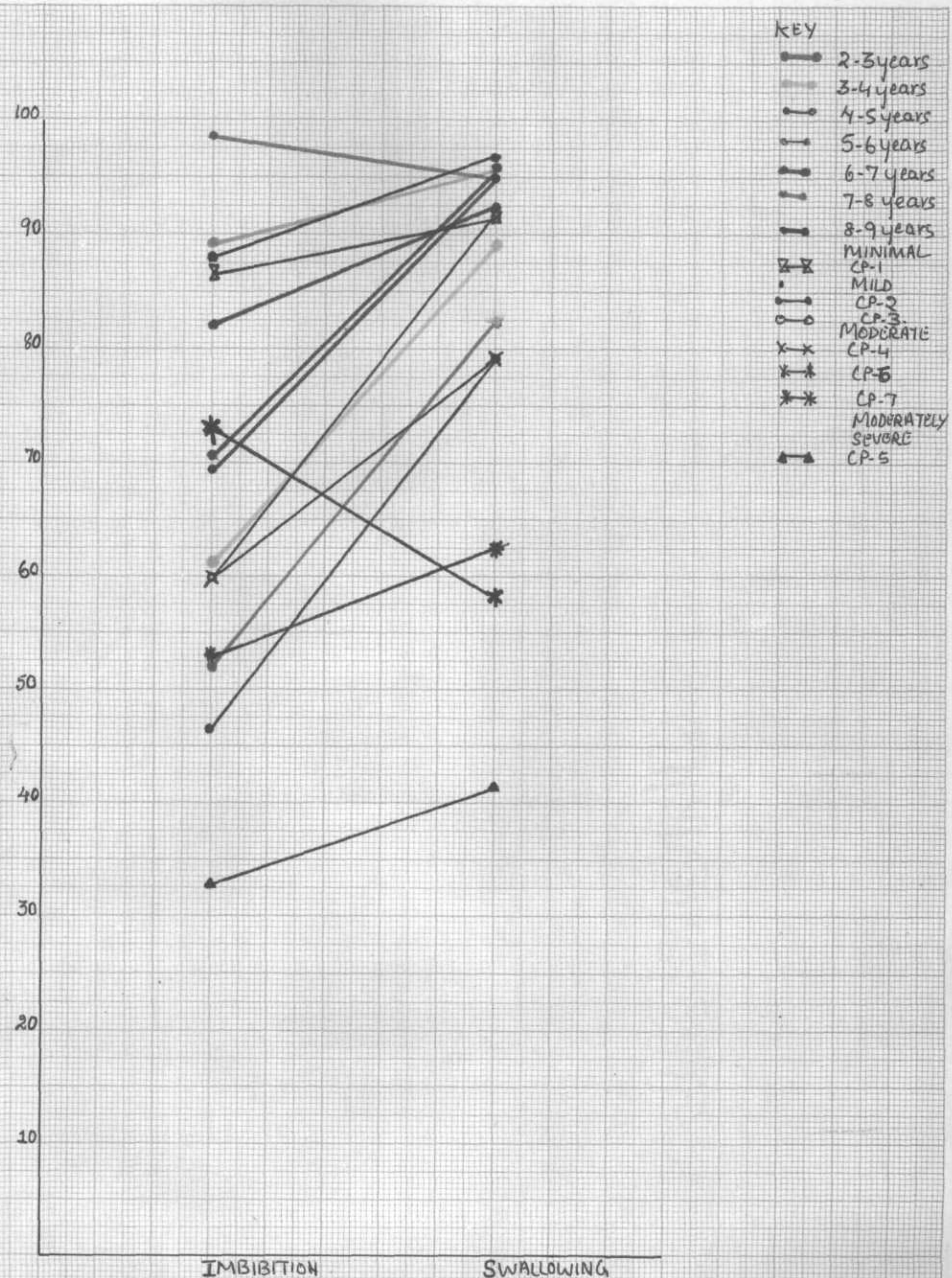


FIG. 11b. Deglutition of liquids in normals and spastics.

adult group? masticatory performance and swallowing falls in the age range 5-6 years.

Dealutition of liquids: Imbibition is inpar with the adult group, but that of swallowing is in par with the performance of 6-7 year olds.

Mild oral involvement:

CP 2: Age 3.5 years:

Deglutition of solids: Performance on imbibition is in part with the age group 2-3 years and that on mastication and swallowing below the lower limits of the age range studied.

Dealutition of liquids: Performance on both imbitition and swallowing falls below the lower limits of the age range studied.

CP 3: Age 4.2 years

Deglutition of solids: Performance on imbibition falls in the age range 2-3 years and that on mastication and swallowing falling below the lower limits of the age range study.

Dealutition of liquids: Performance on both the parameters of deglutition falls in the age range 3-4 years.

Moderate involvement:

CP 4: 4.6 years.

Dealutition of solids: Performance on all the parameters of deglutition falls below the lower limits of the age range studied.

Deglutition of liquids: Performance on imbibition falls in the age range 3-4 years and that on swallowing, falls below the lower limits of the age range studied.

CP-6: Age 7.8 years:

Deglutition of solids: Performance on imbibition is in par with the peers and that on mastication and swallowing falls below the lower limits of the age range studied.

Deglutition of liquids: Performance on imbibition is in par with that of 4-6 years age group and that on swallowing falls below the lower limits of age range studied.

CP 7: Age 13.5 years.

Deglutition of solids: Performance on imbibition is equivalent to that of the age range 2-3 years, and the scores on mastication, falls below the lower limits of the age range studied.

Deglutition of liquids: Performance on imbibition is in par with that of 2-3 years olds and that on swallowing falls below the lower limits of the age range studied.

Moderately-severe oral involvement:

CP 5: Age 5 years.

Dellutition of solids: Performance on all the parameters of deglutition fall far below the lower limits of the age range studied.

Deglutition of liquids: Performance on both imbibition and swallowing fall far below the lower limits of age range studied.

The above findings high light the homogeneity in the heterogeneous condition of cerebral palsy. It can be noted that, as a group, the performance on deglutition of solids of the cerebral palsied falls below that of the normals in the act of mastication and swallowing, but overlaps with the norm on imbibition function except in the moderate and moderately severe groups. Despite the age differences, the homogenity in scores obtain may aid in categorizing the spastics based on the degree of oral involvement. Likewise in deglutition of liquids, there is a considerable overlap in performance on imbibition (which may or may not be in par with the peers), but the poor performance on swallowing act reflects the presence of pathological features. The relatively better performance on swallowing of liquids when compared to that of solids in CP 1 and 3 may be attributed to the relatively easy oral maneuvering,the oral and pharyngeal transits being assisted by gravity owing to the assistive head tilt.

The above findings implicate the need for detailed assessment of oral pharyngeal dysphagia coocurring with dysarthria in the cerebral palsied. The developmental data aids in (i' establishing the base line deglutition age, (ii) provides directions in the management of deglutition by enlisting the parameters that ought to be tackled (primitive versus pathological) for a given client in relation to his peer group, proceeding in the developmental sequence, (iii) Provides the post therapy deglutition age which ought to coincide with that of the peer groups and not necessarily represent the adult pattern in the lower age groups.

Limitations of the study:

1. Ability to categorize the cerebral palsied based on the degree of oral involvement in lieu of the homogenous scores obtained in deglutition requires in depth investigation owing to limited sample size chosen in the current study.
2. A wider range of food materials of different consistency, for instance, semi solids and in lieu of the observation that continued drinking of milk and citrus juices poses minor problems even in normals (probably due to the mucHagenous secretion); etc. could have been testedy
3. Wider rating scale could have been adopted to account for the finer details of patterns of deglutition.
4. Inner rater reliability to eliminate professional bias is implicated. This was not employed in lieu of the time factor involved in observation and accurate transcription necessitating familiarity witbthe specified task. Only test-retest reliability could be obtained.

SUMMARY AND CONCLUSION

Current status of speech therapeutics in amelioration of dysarthria in cerebral palsy has seen a universal prescription of oroneuromotor vegetative exercise*. This is based on the premise that speech and deglutition ("... the process whereby a bolus, liquid or solid, is transferred from the buccal cavity to the stomach" - Lund, 1987) have manifold connections, with the two automated motor acts developing in parallel or subserved at least in part by different neuronal structures (Netsell, 1986). Providing a finesse to our therapeutic regime demands an insight into this oral motor physiology of deglutition. In lieu of the inevitable application of the transdisciplinary team approach, borrowing principles in practice from the allied professions in Indian set up, the current study is an attempt.

1. to obtain a developmental profile of oral-pharyngeal deglutition based on direct visual, tactual and auditory information;
2. to gauge the status of deglutition in spastic cerebral palsied, enlisting the normal/hear normal; primitive and pathological features;
3. to study the relationship between speech (articulation and voice) and oral pharyngeal deglutition).

Hypotheses:

1. There is no difference in the eating habits (oral and pharyngeal phases of deglutition)& speech in normal children of different age groups and normal adults.
2. There is no difference in the act of oral pharyngeal deglutition,in spastic cerebral palsied and normals.
3. There is no relationship between the motor acts of deglutition and speech.

Methodology: The study was staged in the following steps:

1. Development of the test protocol based on review of literature andpilot study. The test format included -
   (i) Articulation testing in isolation and word level of all the Kannada phonemes from the Test of Articulation in Kannada - Diagnostic Form B (Rathna, Babu, Bettageri, 1972) (Dentals and velars)
   (ii) Deglutitiop6f solids - imbibition (2 parameters) mastication (12 parameters) and swallowing (8 parameters).
   (iii) Deglutition of liquids - imbibition (5 parameters) and swallowing (8 parameters) for quantitative analysis) (details furnished in Table-2.

The testing on deglutition was performed in natural and simulated interrupted conditions with instruction to cease the deglutition act when required and noting the corresponding response. A semiquantified rating scale, rated 1 through 3 (1 = abnormal; 3 = normal adult pattern) was designed to transcribe the data for further analysis.

Administration of the test: The test was administered to a group of 12 randomly chosen adult females, age ranging 17-25 years; 35 normal children, age ranging 2-9 years, divided into 7 subgroups on the age basis (2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9) and 7 verbal spastic cerebral palsied (1 - minimal? 2- mild, 3- moderate and 1 with moderately severe oral involvement) with no significant retardation contributory to speech delay, age ranging 3.5 - 13.5 years. All the subjects were essentially otologically normal, with no alimentary or respiratory tract infection at the time of testing. The testing was individualized with distractions kept to a minimum.

Analysis, results and discussion:

1. Deglutition of solids: The transcribed data was analyzed for patterns, if any across the age groups studied in different parameters of deglutition. Table-21.a.enlists these parameters in terms of the pattern obtained.

Table -21 a: Paramters of deglutition of solids and their corresponding (developmental or otherwise) trends.

Deglutition stage.	Parameters			
	Developmental trend	No developmental trends.		
		Exhibiting early plateau	'Predictability Yes	1 No
Imbitition	Oral structure employed in spoon clearance.	Efficiency		
Mastication	Chewing sound Accompanying labial movements. Ability to detect food position. Retention/spillage Mode of labial clearance Range of mandibular movement Accompanying lingual movements. Food placement.	Biting (Mature + adequate) Mandibular arc traversed		Chewing efficiency.
swallowing	Cohesive bolus Retention/spillage Mandibular stability Post swallow intra-oral examination after 1 minute for presence of residue/ parking bolus.		Laryngeal elevation Masseter contraction Circum-oral tension. Lingual positioning.	

Table-21 b: Parameters of deglutition of liquids and their corresponding (developmental or otherwise)trends.

Deglutition stage	Parameters			
	Developmental trend	No developmental trends		
		Exhibiting early plateau	*Predictability Yes	No
Imbibition	Position of glass Degree of lip protrusion Degree of cheek indrawing Positioning of straw Degree of lip closure			
Swallowing	Amount of fluid sustained in anterior seal(may predict presence or absence of tongue thrust in adults). Mandibular stability. Spillage/retention during swallowing	Adequacy of anterior seal formation. Adequacy of posterior seal formation.	Lacyngeal elevation Masseter contraction Circumoral tension Lingual positioning.	

The above findings implicate that the parameters showing a developmental trend may be subject to maturational influences. For instance, an increase in size of the oral and pharyngeal region may provide greater area for lingual accommodation (as suggested by Mason and Proffit, 1974). This together with appearance of the dentition responsible for grinding the bolus (premolars and molars) may account for the shift from anterior to central and lateral food placement in the upper age group, and a decrease in lingual fronting and spillage during swallowing.The type of tongue thrust seen in the age groups above 4 years with interdental fixation rather than the antero positior sweeping action (and thence reduced pressurization on the hard palate) may account for the exaggerated rugae palatini in the tongue thrusters of upper age groups. This anatomo-physiological maturation interacts closely with the socially conditioned sophistication.

Factors showing early plateauing of scores like mandibular arc traversed in chewing implicate and investigation into the transmission stages from reflexive biting brought over to voluntary automated shewing level. The section marked *predictability implicates the plausible relation to the tongue thrust syndrome, with a high coexistence of marked circum oral tension, abnormal interdental lingual positioning,weak masseter contraction and weak laryngeal elevation(as also reported by Palmer, 1962). Chewing efficiency is not predictable in normals, a better indicator being an objective data based on particle size. This may inturn reflect the swallowing efficiency, on the basis of absence of minimal presence of residue on immediate post swallow inrra oral examination.

Deglutition in spastic cerebral palsied:

The findings reveal a homogeneity in the heterogenous condition of cerebral palsy, with the normals and the spastics falling under widely differing performance scores on the acts of mastication and swallowing, with an overlap in the imbibition function. Deglutition scores may reflect the degree of oral involvement as seen in the differential scores exhibited in the 4 categories of cerebral palsy. The primitive features i.e. those se*en normally in the lower age groups and the pathological features interfering with the different stages of deglutition have been enlisted for each parameters of deglutition, which provide directions for symptom management. For instance, CP 1 with minimal oral involvement would require the following management lines

Chewing: Faster mandibular movement with emphasis on closed mouth chewing and placement of food on grinding dentition.

Swallowing: 1) Formation of lateral seal (2) Formation of cohesive bolus with attempts at forming anterior seal with lingua alveolar placement with mouth open, retaining about 20 ml. (starting from 5 ml onwards) of water. This would in turn aid in reduction of circum oral tension. Provision of tactual information for laryngeal elevation and masseter contraction may aid in normalization of the 2 acts. Also, in lieu of the plausible connection of the above with the tongue thrust syndrome, there may a concomitant normalization of masseter contraction and laryngeal elevation with instruction on appropriate lingual positioning.

Relationship between speech and deglutition:

The data on articulation and voice in relation to deglutition suggests a close relationship between the two motor acts. Here only the sounds involved in tongue thrust have been considered, together with lingua velar articulation. A high incidence of interdental lingual placement in both normals and spastics in articulation of /t//d/,/n/ was found to relate to the presence of inter dental tongue thrust during swallow which also correlated with the amount of liquid retained in formation of anterior seal. The amount of fluid retention in adults in absence of diastema may predict the presence of tongue thrust. Additionally, in CP 5 with moderately severe oral involvement, omission of /t/,/d/ /n/ was found to relate to the inability to form anterior seal and tongue thrust with no contact with the passive articulators. Inability to imbibe via straw/spoon was found to relate to the weak bilabial production /b/ and /p/. In CP 6 and CP 7 with moderate involvement, lax articulation of velar sounds /k/ and /g/ was found to relate to the weak posterior seal in the deglutition act. Post swallow voice change and its normalization after voluntary coughing or throat clearance in CP 5 and CP 7 (moderately severe and moderate involvement respectively) suggests the need for close coordination between the two actsy the change in voice being reflective of any of the following viz. weak swallow reflex, weak laryngeal elevation, coating of food material on the posterior pharyngeal wall, stasis of bolus close to the laryngeal inlet etc. also being supported by swallowing metered-out bolus (piece-meal deglutition even for small sizedbolus) which may indicate apart from inability to handle large size bolus, a fear of aspiration (as also suggested by Logemanw,1986).

Implications: In lieu of the vegetative therapy employed in the alleviation of dysarthria in cerebral palsied, the above findings high light the following:

1) The test format suggested helps in enlisting the primitive and the pathological features in the dysarthric.
2) Vegetative therapy ought to tackle the pathological and normal but primitive features, the latter following the developmental sequence. Thence the base line deglutition age may be compared to the post therapy deglutition age which ought to be in par with the chronological age and not necessarily the adult pattern for the lower age groups.

The developmental profile provides the directions for this vegetative therapy(for instance, the mode of imbibition - the straw placement, degree of cheek indrawing permissible etc.)

3) owing to the closs relationship between articulation and deglutition, alleviation of oral-pharyngeal dysphagia may bring about a concomitant symptom management of dysarthria. Likewise, spillage and aspiration, tackled via vegetative therapy may bring about a normalization of the wet gurgling voice quality seen in some spastics owing to stasis of saliva close to the Laryngeal inlet.

4) The data can be applied to other clinical populations as in the myofunctional therapy for cleft palate, and other neurogenic speech disorders.

Directions for further research:

1. Norms refleeting the developmental profile ought to be established with larger sample for the parameters of deglutition.
2. The primitive/pathological features of other classes of cerebral palsy need to be obtained.
3. The developmental data ought to be applied therapeuticaily to confirm the relationship between the two motor acts of deglutition and speech.

4. Evaluation of oral sensory-perceptual skill in relation to deglutition may be studied which may provide lines for better management of oral pharyngeal dysphagia and dysarthria in the cerebral palsied.

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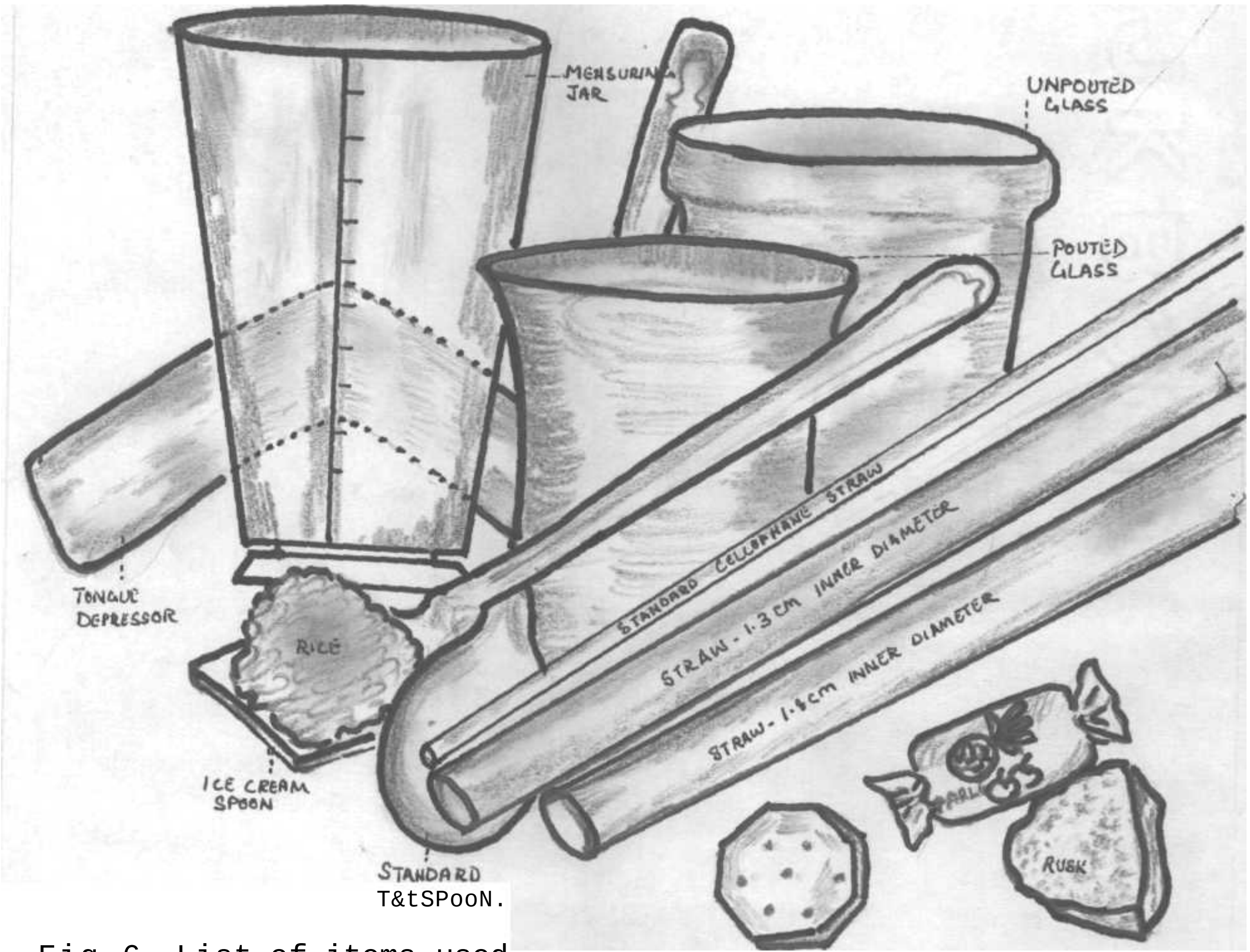
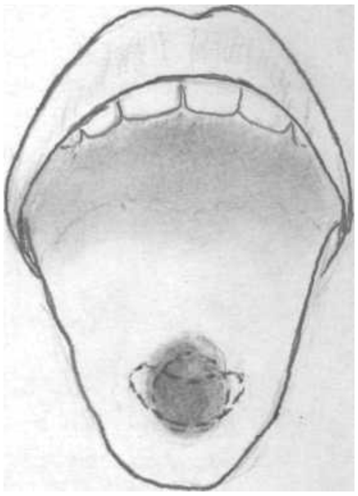


Fig.6. List of items used

Fig. 7. Testing for ligual posture, circum oral tension masseter contraction and laryngeal elevation



F i g 8.a. Cohesive bolus in pit

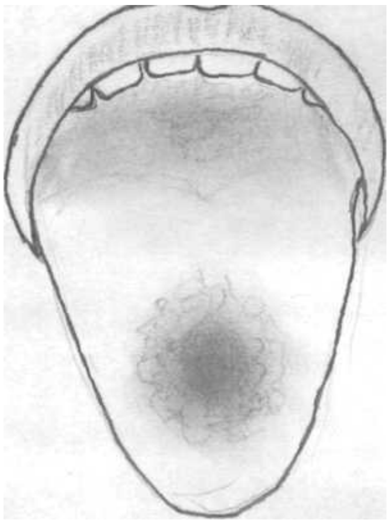


Fig.8.b Bolus spreadout

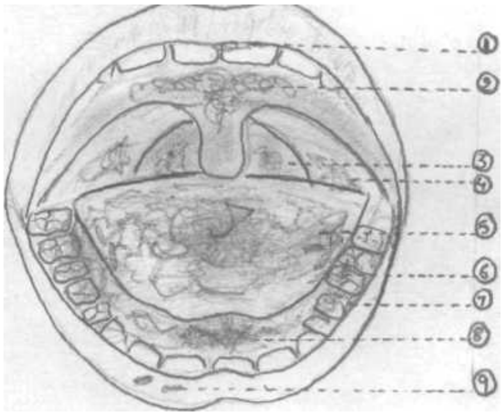


Fig.gc- Bolus present elsewhere 1 = anterior sulcus; 2 = palate; 3 = posterior pharyngeal wall; 4 = fauces 5 = tongue; 6 = dentition; 7 = lateral sulcus: 8 = sublingual region; 9 = on lips

Table-19: Scores obtained on deglutition of solids and liquids for normals

Parameters	Age in years							
	2 -3	3-4	4-5	5-6	6-7	7-8	8-9	Adults
Solids								
Imbibition	5	5.4	5.2	5.4	5.8	5.8	5.8	5.8
Biting	3	3	3	3	3	3	3	3
Chewing	23	24.6	25.6	28.6	30.6	30.4	31.8	31.4
Swallowing	17.8	17.8	23.8	21.4	22.2	21.4	21.6	21.1
Total	48.4	51.4	57.6	58.4	61.6	$0.2	62.2	61.3
Liquids								
Imbibition	7.8	9.2	10.6	10.4	12.6	14.8	13.4	13.2
Swallowing	19.8	21.4	23	22.8	22.2	22.8	23	23.2
Total	27.6	30.6	33.6	33.2	34.8	37.6	36.4	36.4

Table- : Percentage of scores for normals and spastic on parameters of deglutition of solids and liquids.

Clients		Solids			Liquids	
		Imbibition	Mastication	Swallowing	Imbibition	Swallowing
children	2-3	83.3	72.2	74.2	52	82.5
	3-4	90	76.7	74.2	61.3	89.2
	4-5	86.7	79.4	99.2	70.7	95.8
	5-6	90	88.8	89.2	69.3	95
	6-7	96.7	93.3	92.5	84	92.5
	7-8	96.7	92.8	89.2	98.7	95
	8-9	96.7	96.7	90	89.3	95.8
Normal adults	A	96.7	95.6	87.9	88	96.7
Spastics	CP-1	100	86.1	75	86.7	91.7
	CP-2	83.3	63.9	66.7	46.7	79.2
	CP-3	83.3	58.3	66.7	60	91.7
	CP-4	66.7	63.9	50	60	79.2
	CP-5	33.3	47.2	45.8	33.3	41.7
	CP-6	100	55.6	37.5	73.3	58.3
	CP-7	83.3	63.9	50	53.3	62.5