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Dysphagia

The Exeter Dysphagia Assessment Technique

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Abstract. The Exeter Dysphagia Assessment Technique (EDAT) uses noninvasive equipment to record, simultaneously, "feeding respiratory patterns," the time drink entered the mouth, and associated swallow sounds during feeding. The easily portable equipment enabled patients' swallowing ability to be tested, at the bedside if necessary, using a small amount of fruit-flavored drink. The results appear in chart form.

EDAT findings from groups of normal subjects aged 2–90 years were compared with those from patients with dysphagia of neurologic origin and normal subjects under experimental feeding conditions. The results revealed maturation of the feeding respiratory pattern in the teenage years and remarkable consistency thereafter. Differences in the recordings between the normal and abnormal subjects were sufficiently marked to allow the findings to be used in the diagnosis of other patients with dysphagia of doubtful neurologic cause. Interpretation of the charts and recorded timings of the oral and pharyngeal stages of swallowing permitted a more accurate identification of sensory nerve, motor nerve, and functional involvement causing dysphagia of neurologic origin and may be used as a guide to the origin of the sensory deficit.

Key words: Deglutition – Respiration – Feeding respiratory patterns.

The effective management of patients with dysphagia depends on the accuracy of the diagnosis. When dysphagia is due to obstruction, the diagnosis is generally uncomplicated. Dysphagia of neurologic origin, however, may be due to a variety of neuromuscular abnormalities that can only be assessed by observing function. Even then it may be difficult to determine whether an abnormal swallowing condition may be attributed purely to motor loss, sensory feedback deficiency, loss of memory of learnt experiences, suppression by the higher centers of the brain, or combinations of these with varying degrees of involvement. Large numbers of neurologically impaired patients with dysphagia get little help with swallowing, often due to the difficulty in establishing a diagnosis, which relies mainly on clinical judgement by an experienced clinician, with the occasional assistance of a radiologist using videofluoroscopy.

Investigation of normal swallowing and the assessment of oropharyngeal dysphagia of neurologic origin involves studies of coordination and efficiency of the various parts of the oral and pharyngeal neuromusculature. The regulation of respiration during swallowing is an essential part of a well-coordinated swallowing mechanism, yet little attention has been paid to this aspect during investigations of dysphagia. Nishino et al. [1], however, recorded respiration during swallowing in subjects lying supine and wearing a nose clip.

Recent research [2] showed that in normal young and elderly adults, respiration was not simply arrested during the pharyngeal stage of swallowing. Instead, a complex rhythm occurred that was initiated as food or drink approached the lips, continued until the bolus had entered the esophagus, and included a period of deglutition apnea. The complexity of the "feeding respiratory pattern" and the finding that, in a given adult, the pattern was repeated in 95% of swallowing events, lead to the conclusion that it was controlled by many reflex arcs dependent on efficient sensory

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input. Conversely, the well-regulated respiratory patterns during deglutition were absent in adult patients with known neurologic diseases, who were experiencing dysphagia mainly due to sensory impairment [3]. However, similar recordings made from patients with motor nerve impairment, who were also suffering from dysphagia, showed respiratory patterns similar to those found in normal subjects. These well-regulated feeding respiratory patterns, in normal subjects who are unaware that respiration is under investigation, may be altered voluntarily by the subject making a determined effort.

The Exeter Dysphagia Assessment Technique (EDAT) was originally designed to enable respiratory behavior during swallowing to be recorded in a simple noninvasive manner; the equipment is portable so that it can be taken to the bedside if necessary. By simultaneously recording the time when food or drink enters the mouth and the associated swallow sounds, it is possible to obtain timings of the oral and pharyngeal stages of swallowing and to relate these to the respiratory events. It may be used by the "swallow therapist" with the patient in bed or sitting, using normal food or drink, without any limit on the length or frequency of repetition of the test.

The present study was designed to establish the normal respiratory feeding pattern over a wide range of ages and to determine the extent to which these patterns changed in patients with known abnormal neurologic conditions affecting swallowing. We wished to determine whether this technique would aid in diagnosis and therefore in the formulation of rehabilitation regimens, and in particular if EDAT could be used to help assess sensory perception associated with feeding.

Subjects

Approval was obtained from the Medical Ethics Committee of Exeter District Health Authority.

Three groups of subjects were used in this study: normal subjects, neurologically impaired subjects with dysphagia, and normal subjects under experimental conditions (e.g., blindfolding, use of topical anesthetics).

Normal Subjects

To establish normal behavior, the EDAT was used on four age-groups of healthy subjects: 25 children aged 2–11 years (11 girls and 14 boys) with a mean age of 7 years; 23 school pupils aged 11–18 years (11 female and 12 male) with a mean age of 14 years; 15 volunteer university students and staff (5 women and 10 men) aged between 18 and 30 years with a mean age of 21 years; and 18 elderly adults without neurologic disease or swallowing problem (9 women and 9 men) aged between 60 and 90 years with a mean age of 76 years.

Neurologically Impaired Patients with Dysphagia

The second group was comprised of patients with dysphagia diagnosed as due to neurologic impairment. The patients tested consisted of 11 who had sustained cerebrovascular accidents aged 71–82 years (6 men and 5 women) and 5 with motor neuron disease, aged 50–84 (2 men and 3 women). These subjects were consecutive patients, referred as a matter of routine to one author (WGS). No prior radiographic study was performed.

Other Normal Subjects

A further study was made on 3 normal subjects aged 63, 75, and 85 who were not included above, but who were subjected to varying experimental swallowing conditions, as described later.

Materials

The subjects were investigated while drinking 5 ml of fruit-flavored drink from a stainless steel teaspoon with a 2 m length of wire soldered to its handle. This joint and the whole of the handle of the spoon were electrically insulated by polythene tubing that had been shrunk over them. Testing swallowing ability by offering this small volume of fruit-flavored drink was done for three reasons: to standardize a technique, to avoid the complication of mastication, and because the drink, in a well controlled amount, was considered to be a reasonable risk to test swallowing ability when the airway is in danger from aspiration.

The entry of the drink into the mouth was recorded using a Visual Speech Aid control box [4] as a contact sensor. The 2 electrodes were a metal spoon with an insulated handle and an indifferent electrode attached by Micropore tape to the cheek of the subject (Fig. 1). This electronic switch detected contact between spoon and lip. Breaking of this contact was taken to be the point at which the complete spoonful entered the mouth.

The swallow sounds, which mainly consist of two "clicks" [5], were recorded by placing a self-supporting throat microphone below the angle of the mandible. When abnormal swallowing actions were being recorded, the swallow sounds may be difficult to interpret because of other noise detected by the microphone. To help identify the swallow sounds under these conditions, an electronic marker was put onto every recording when the operator judged that the swallowing had occurred by observing laryngeal elevation.

The direction of nasal airflow was determined by inserting the soft tips of a nasal cannula (model 1108, Hudson Oxygen Therapy Sales Co.) into the subject's nostrils and connecting the associated tube to a micromanometer (Furness FCO14, sensitivity 10 mm H_2O full scale). The volume of air flowing was not recorded, only the event and the direction of airflow: an expiration caused increased pressure and an inspiration caused reduced pressure. Oral airflow was not recorded because experiment by the authors had shown that it was always accompanied by some nasal airflow. The only exceptions to this phenomenon are during normal speech and blowing through the mouth. This had the advantage of avoiding the complexity of recording oral airflow in a subject who was being fed.

The signals from these three pieces of equipment were recorded simultaneously on to an audio cassette tape via a four-channel tape recorder (Teac R-61). Charts were made subsequently from the tapes using a Gould 2200S chart recorder. Three parameters were recorded: the time at which the drink

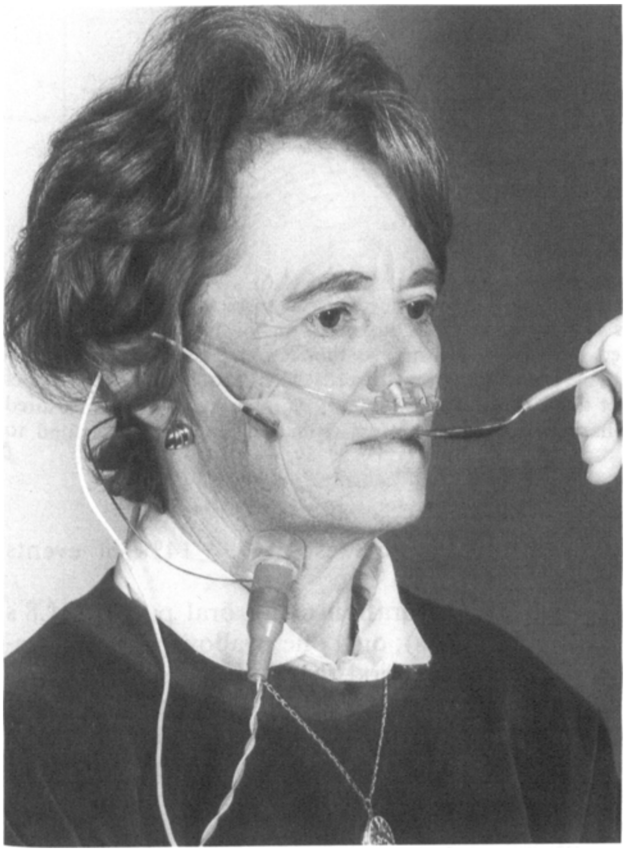


Fig. 1. EDAT attached to subject.

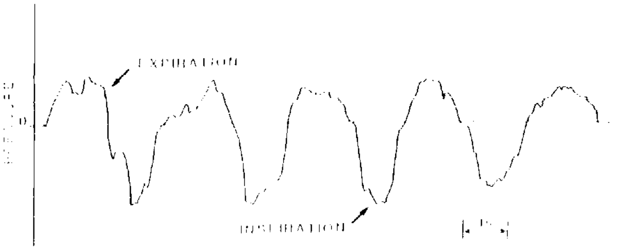


Fig. 2. Trace from micromanometer during normal resting respiration.

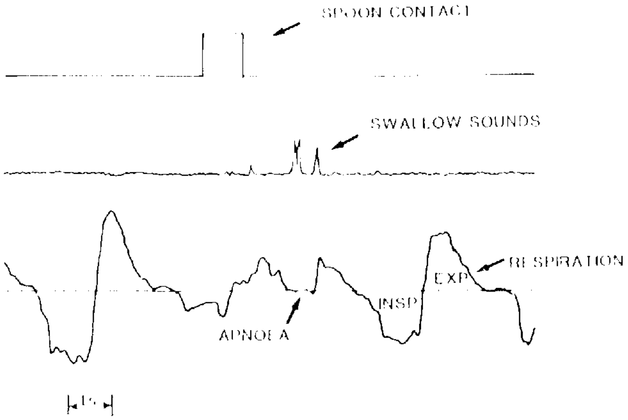


Fig. 3. Upper trace illustrates lip/soon contact, middle trace shows electronically processed signals of the swallow sounds from throat microphone; lower trace, obtained from the micromanometer during feeding, shows feeding respiratory patterns while subject takes and swallows 5 ml fruit-flavored drink.

entered the mouth, the sounds associated with the swallowing event, and the respiratory pattern before, during, and after the drink was swallowed. The optimum chart speed was found to be 10 mm/s, producing a chart about 2 m long for each test.

Method

The subjects were seated comfortably or supported in bed with pillows and the equipment was attached. They were told that the equipment would record swallowing and that they would be asked to swallow fruit-flavored drink from a teaspoon repeatedly. No mention was made that breathing was to be recorded.

Resting respiration was recorded to establish the pattern of the individual's normal, nonfeeding pattern. Recordings continued as the drink was repeatedly offered on the special spoon and swallowed. The interpretation of the recordings was found to be simplified by allowing the subject to take two or three breaths between each spoonful. To identify the rhythm, the ideal requirement was found to be 10 nonfeeding respiratory cycles and 10 swallow events.

Results

Before discussing the data in detail, it is necessary to consider the chart lengths. A chart 2 m long cannot be shown without loss of important detail in a publication, yet the regularity of the occurrence of the events is an important part of the assessment. Usually this can be seen from the charts, but in this paper the repeatability over a large number of swallows, both for an individual and between subjects, will be illustrated later using scatter graphs (see Fig. 5).

The data showed that the 18–30-year-old group of normal subjects produced consistent patterns, so the results from their charts were used as a basis for comparison with other groups, including the normal subjects in other age groups.

Detailed Analysis

Figure 2 shows a trace obtained from the pressure transducer, recording nasal airflow during normal resting respiration, of four and a half respiratory cycles in approximately 10 s.

Figure 3 shows three simultaneous traces. The upper trace shows lip/spoon contact; the middle trace shows the electronically processed signals from the throat microphone; and the bottom trace shows the feeding respiratory patterns associated with taking and swallowing 1 teaspoonful of the drink. Note first that the respiratory trace in this

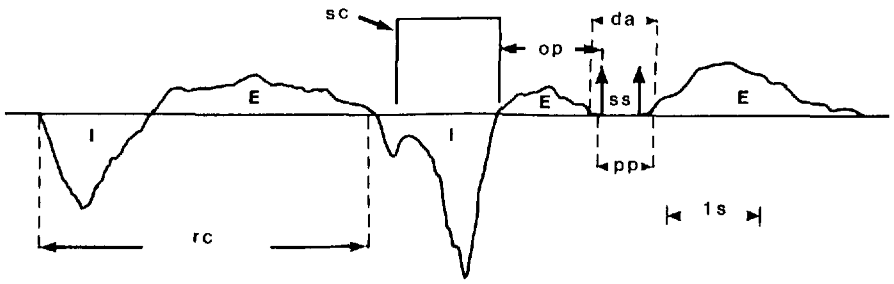


Fig. 4. Feeding respiratory trace with superimposed associated events. *E*, nasal expiration; *I*, nasal inspiration; *rc*, respiratory cycle: one cycle of resting respiration; *da*, deglutition apnea: this is the period when no nasal airflow was recorded during the pharnygeal stage of swallowing; *ss*, swallow sounds: represented by two vertical arrows that correspond to the two clicks of the swallow sounds; *sc*, spoon contact; the period marked by two vertical lines that records when the spoon is in contact with the lips; *op*, oral part: measured from the end of spoon contact to the first swallow sound; *pp*, pharyngeal part: measured from the end of spoon contact to the first swallow sound; *pp*, pharyngeal part: measured from the first swallow sound to the start of the postswallow respiration.

figure shows a period of apnea coinciding with the swallow signals. Both before and after this period of apnea, complex respiratory events occur, the essential features of which are repeated in subsequent swallows in a given subject.

Superimposition of the respiratory trace and the events from the other two traces of Figure 3 allowed for easier analysis and this form of presentation, shown in Figure 4, will be used hereafter. The definitions of the terms used are shown in the caption of Figure 4. The terms '*oral part*' and '*pharyngeal part*' were carefully chosen in this study since, although the timing and clinical value of these events are similar to those of the '*oral phase*' and '*pharyngeal phase*' (terms commonly used when analyzing a modified barium swallow videofluorescopic investigation), we have not yet made a comparison of the timings with simultaneous recordings of both investigations. The oral part was measured from the end of spoon/lip contact to the first swallow sound and the pharyngeal part was measured from the first swallow sound to the start of respiration after the swallow had occurred.

Analysis of Normal Groups Under Normal Conditions

The characteristic findings of clinical relevance in subjects in the 18–30 year group may be summarised as follows:

Before lip/spoon contact: Evidence of "pacing" of respiration that curtails the expiration immediately before lip/spoon contact.

During lip/spoon contact: The respiratory pattern was either an inspiration as shown in Figure 4, or an inspiration/expiration combination. Whichever pattern was recorded, it was repeated regularly throughout the test in $79 \pm 14\%$ of events (range 58–100%).

Oral part: Duration of an oral part 0.7–1.8 s (mean, 1.1 ± 0.4 s); only one swallow per teaspoonful; during this period there was either an expiration (in 80% of the subjects), as shown in Figure 4, or a period of apnea, as shown in all the traces in Figure 11 below. Whichever pattern occurred in an individual, it was maintained in $95 \pm 6\%$ of events (range, 82–100%).

Pharyngeal part: Rarely was a swallow sound corrupted by other associated noise relating to coughing or spluttering; consistent duration between 0.4 and 0.7 s (mean, 0.5 ± 0.1 s) for all subjects; the end of the pharyngeal part was followed by an expiration in $92 \pm 10\%$ of all swallowing events.

Normal Variations with Age

Figure 5 shows the variations with age of the duration of the oral part and pharyngeal part, respectively, together with the data for an individual chosen from the 18–30 years age group for comparison.

The 60–90-years age group showed only slightly longer duration of the oral part (0.5–2.9 s, mean 1.4 ± 0.6 s) and this was not statistically significant with respect to the 18–30-year age group, although the increased duration of the pharyngeal part (0.6–1.0, mean 0.7 ± 0.1), was significantly different ($P = 0.05\%$).

The children aged 2–11 years and the 12–17-year-old group exhibited times for oral and pharyngeal parts similar to those of the 18–30-year-old group. However, two differences were noted. First, in children under 11 years, sometimes 2 swallows per teaspoonful were recorded.

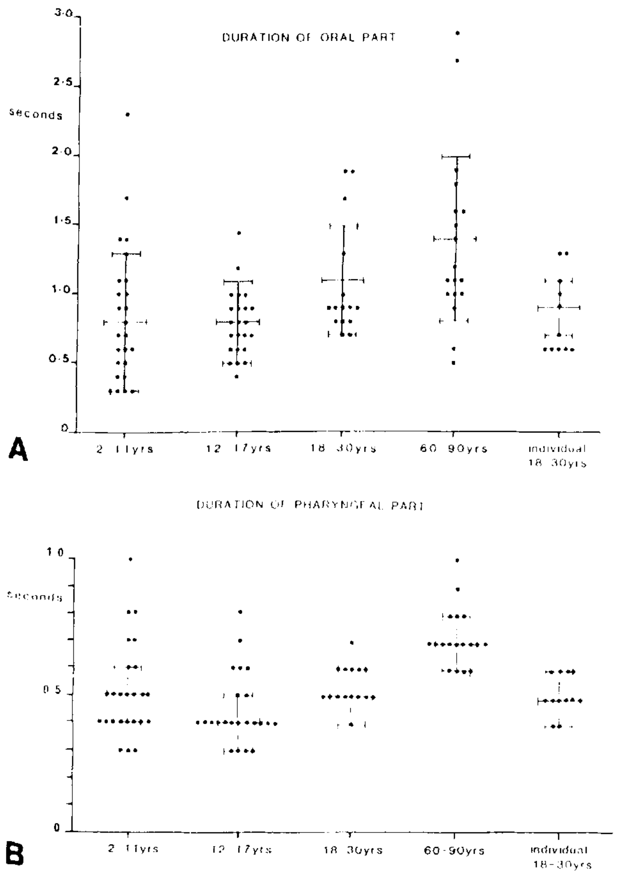


Fig. 5. A Variation with age in normal subjects of average durations of oral part and the spread of data for an individual in the 18-30-year group. **B** Variation with age in normal subjects of average durations of pharyngeal part and the spread of data for an individual in the 18–30-year group.

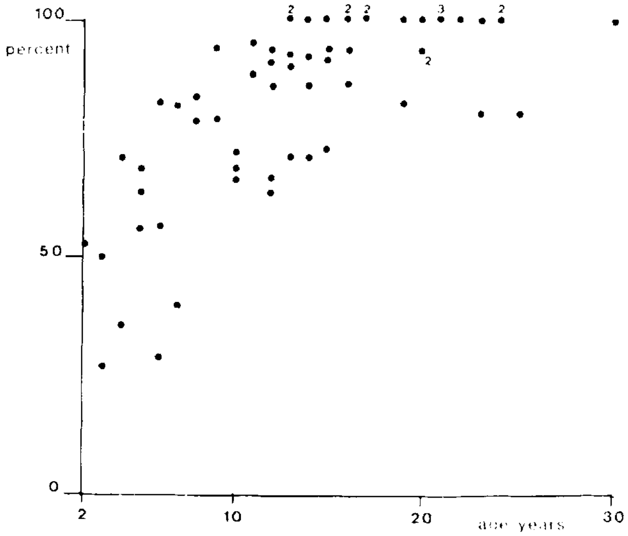


Fig. 6. Percentage of expirations ceasing immediately before lip/spoon contact plotted against age in years in normal subjects aged 2–30 years.

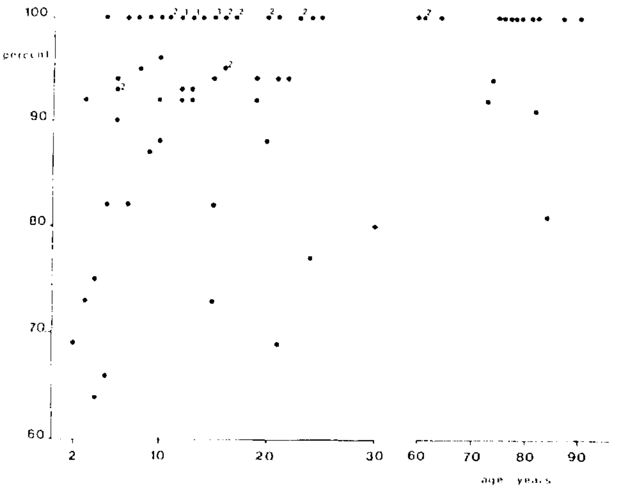


Fig. 7. The percentage of swallows followed by an expiration plotted against age in years for normal subjects.

Second, expirations did not always cease immediately before lip/spoon contact. The percentage of expirations that ceased before lip/spoon contact over the whole range 2–30 years is shown in Figure 6. The percentage in the 60–90-year-old group continued at the same level as the 18–30-year-old group.

The percentage of swallow events followed by an expiration was consistently high for all age groups and is shown in Figure 7, the average being 89% in 2–11-year-olds and 98% in 60–90-year-olds.

Normal Self-Feeding Subjects

All the above results refer to subjects being fed. During self-feeding (e.g., taking soup from a spoon) another element is involved: the motion of the arm must be linked with lip/spoon contact. It was possible that a feedback mechanism with the central nervous system was influencing the swallowing mechanism. This was tested in three normal subjects. Figure 8 shows two traces: the upper while the subject was being fed and the lower when another subject was self-feeding. The essential features of the two traces are very similar and seemed to exclude any central neurologic effect of arm movement on the actual swallowing mechanism.

Neurologically Impaired Subjects with Dysphagia

Cerebrovascular Accident. The chart in Figure 9 B may be compared with one from a normal subject (Fig. 9 A). It exhibits the following differences

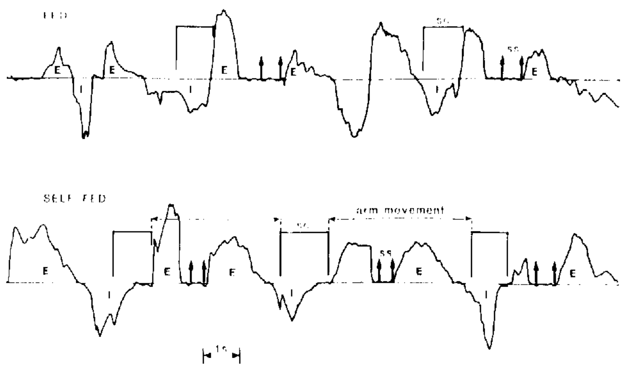


Fig. 8. Comparison between a normal subject being fed (upper trace) and a different normal subject self-feeding (lower trace).

from normal: abnormal respiration at spoon contact, the pattern of which which may vary throughout the test; variable and prolonged oral part; variable direction of respiration after swallowing: the dramatic decrease in the percentage of swallows followed by an expiration in all patients is demonstrated in Figure 10; loss of the normal consistency in the feeding respiratory pattern from one swallow to another.

Motor Neuron Disease. The results from all patients with motor neuron disease were similar. They show normal direction of respiration at spoon contact, an expiration after each pair of swallow sounds, and rapid multiple swallows per 5 ml spoonful. These were never observed in other adults.

Normal Subjects under Experimental Conditions

To determine whether reduced sensory input affected the feeding respiratory patterns, subjects

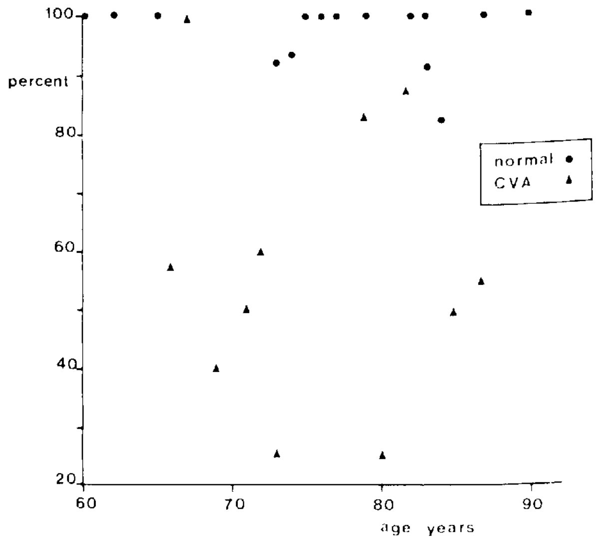


Fig. 10. The percentage of swallows followed by an expiration plotted against age for normal subjects (●) and for patients who have had a cerebrovascular accident (▲).

with apparently normal swallowing were tested, some after being blindfolded and others after receiving pharyngeal anesthesia.

The first group were blindfolded after the normal feeding respiratory pattern had been determined. Figure 11 shows the results for a single subject. In the first test (Fig. 11 A) the subject was fed under the normal test conditions. In the second test (Fig. 11 B) the subject was blindfolded and told when the spoon was approaching the lips: "Here it comes (pause) now!" In the third test (Fig. 11 C), with the subject still blindfolded, no prompt concerning the approaching spoon was given. In the fourth test (Fig. 11 D) the spoon was deliberately

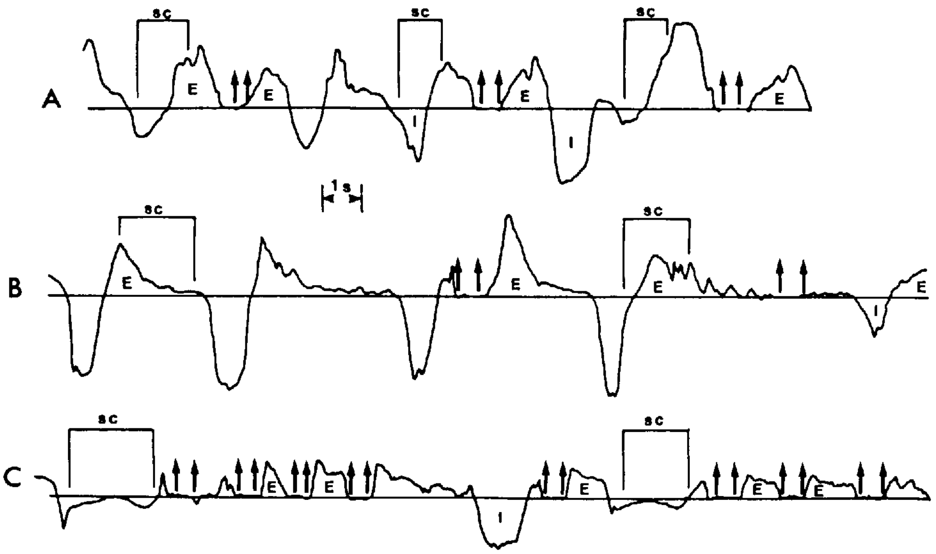


Fig. 9. Tracings from neurologically impaired and normal subjects.
A Normal subject.
B Subject after a cerebrovascular accident and complaining of dysphagia.
C Patient with motor neuron disease and dysphagia.

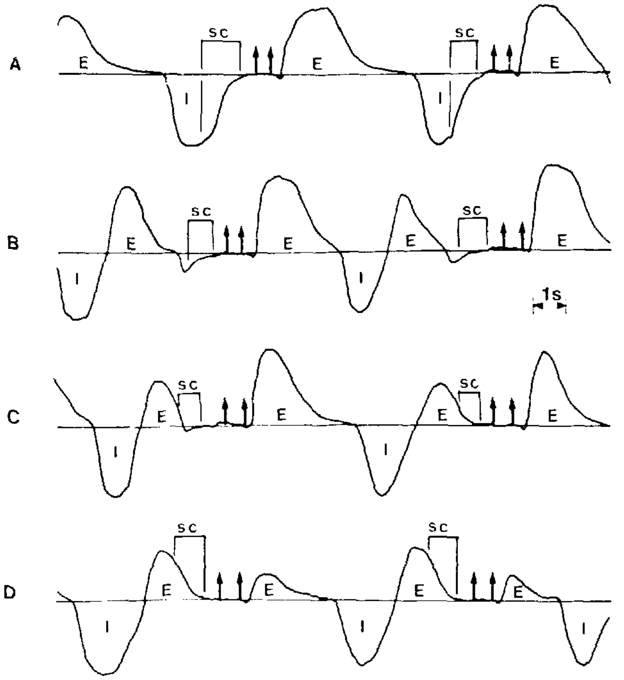
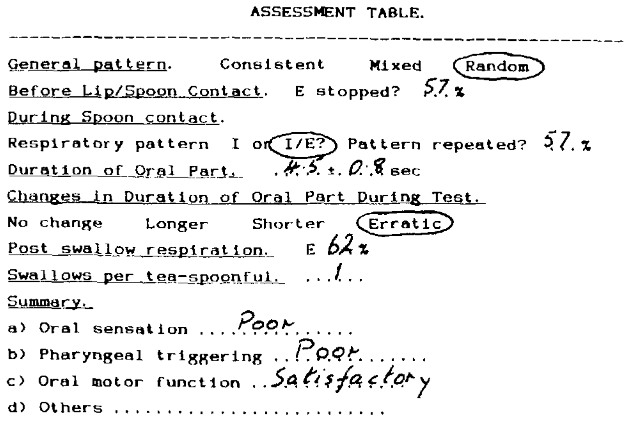


Fig. 11. Tracing from a normal subject under experimental conditions. **A** Normal conditions. **B** Blindfolded, prompted about spoon approaching lips: "Here it comes (pause) now". **C** Blindfolded, no prompt concerning approach of spoon. **D** Blindfolded, spoonful deliberately offered during expiratory phase of respiration, prompt given immediately prior to spoon contact.


ASSESSMENT TABLE.

General pattern. Consistent Mixed (Random)
Before Lip/Spoon Contact. E stopped? 57 %
During Spoon contact.
Respiratory pattern I or (I/E?) Pattern repeated? 57 %
Duration of Oral Part. 4.5 ± 0.8 sec
Changes in Duration of Oral Part During Test.
No change Longer Shorter (Erratic)
Post swallow respiration. E 62 %
Swallows per tea-spoonful. ...1..
Summary.
a) Oral sensation ....Poor.....
b) Pharyngeal triggering ..Poor......
c) Oral motor function ..Satisfactory
d) Others ....

Fig. 12. Assessment table summarizing data from EDAT test on a patient with dysphagia following a cerebrovascular accident.

offered to the blindfolded subject during an expiratory phase of respiration, detected by watching the meter on the micromanometer; indication was only given immediately prior to the instant of lip/spoon contact.

In each of these tests on normal blindfolded subjects the respiratory feeding patterns following the deglutition apnea were the same as those produced in the subject's normal pattern.

In the second group, two patients who were due to have the oropharyngeal isthmus sprayed with a topical anesthetic prior to oral gastroscopy agreed to be tested both before and 4 min after the spray was applied. These subjects were carefully selected and all the implications explained to them. Six applications of 10 mg lidocaine spray (Xylocaine spray, Astra) were used: one spray was directed towards each side of the soft palate, dorsum of the tongue, and the pillars of the fauces, which is the normal procedure prior to gastroscopy. The test proceeded with caution and it was thought prudent to terminate it on the second subject after five small spoonfuls because the patient appeared to become apprehensive.

The following differences between pre- and postspray readings were noted: the overall regularity of the pattern was reduced in both subjects; the duration of the oral part in one subject rose from 1.8 ± 1.4 s to 2.6 ± 1.0 s; both subjects had coughing episodes after the swallow sounds, which suggested possible aspiration; and the fraction of swallows in which the postapnea event was expiration changed from 10/11 to 6/8 and 11/12 to 2/4 expirations, respectively.

Presentation of Data for Clinical Interpretation

When analyzing an individual subject's chart, it is suggested that it be examined in this order, using the definitions in Figure 4: first examine the chart overall to determine whether the patterns of all events are regularly repeated throughout the test; calculate the percentage of events in which expiration has ceased before lip/spoon contact; calculate the mean and standard deviation of the duration of the oral part; determine whether the duration of the oral part is constant, erratic, or varies progressively as the test proceeds; calculate the percentage of swallows followed by an expiration; and count the number of swallows per spoonful.

A table of data may be used to help analyze the basic information and prepare the findings for clinical application. An example is shown in Figure 12 for a patient with dysphagia following a cerebrovascular accident. However, clinicians experienced in neurologic dysphagia will glean more information from EDAT, which is specific to each individual subject and may be helpful in diagnosis, as discussed later. The summary section may be compiled using the information recorded in the assessment table together with other clinical observations.

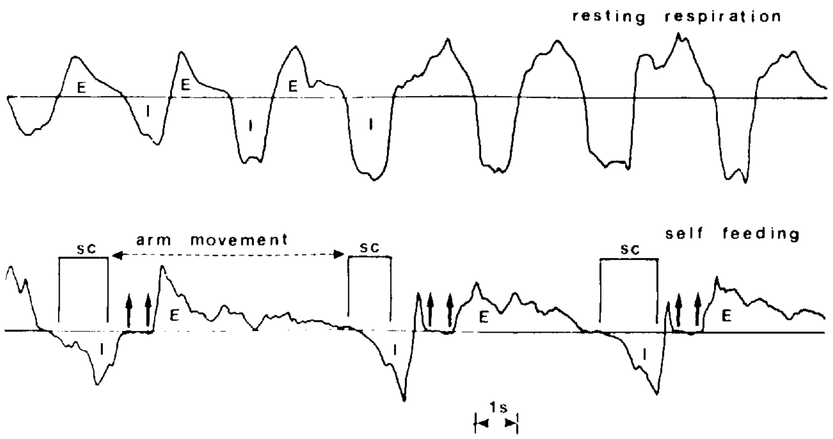


Fig. 13. *Upper trace:* resting respiration from a patient following a stroke and suffering from dyspraxia affecting the arm used for feeding. *Lower trace:* same patient, self-feeding.

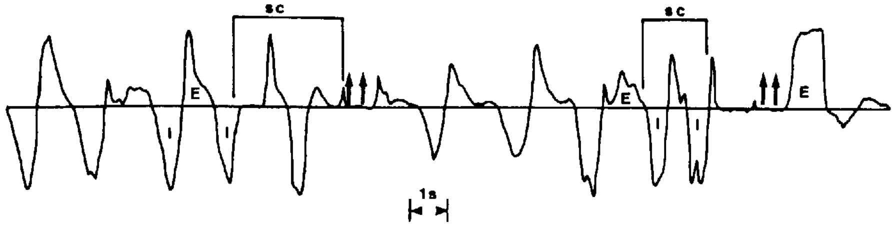


Fig. 14. Tracing from a boy aged 6 years with athetoid cerebral palsy.

Discussion

We have found strong evidence that well-organized, complex respiratory patterns consistently occur during feeding in normal subjects. The complexity of these patterns and their regular repetition suggest that they require sensitive sensory triggering and continuous feedback stimuli from many sources. The "feeding respiratory pattern" appears to become organized with the approaching spoonful and continues until the bolus has left the pharynx.

We have considered other possible explanations for the respiratory arrangement during deglutition, including continuation of the nonfeeding respiratory rhythm with a period of apnea during the pharyngeal stage, and a random combination of inspirations, expirations, and periods of apnea initiated internally in the brain. These explanations have not been supported by EDAT tests on normal subjects, although some have been demonstrated in neurologically impaired subjects with dysphagia.

The finding that respiration is carefully organized *before* lip/spoon contact and matures at about 16 years of age (Fig. 6) is interesting. Evidence of the importance of organization in the swallowing mechanism is demonstrated by the results from a stroke patient who had arm dyspraxia and possibly an impairment of the field of vision. Figure 13 (upper trace) illustrates the resting respiration from a patient who had recovered from a stroke. She had no swallowing problem, but suffered from dyspraxia affecting her right arm and it was with her right hand that she held the spoon to feed. The feeding respiratory pattern recorded under these conditions is presented in the lower trace of Figure 13. The duration of the expiration preceding lip/spoon contact is greatly increased (two to three times) when compared with her normal resting respiration. The duration tended to increase as the test proceeded. The patient appeared to be attempting to maintain end-expiration at spoon contact regardless of the duration of that expiration. This could have been due to poor proprioception as the arm moved through a field of impaired vision. Further evidence has been found in a recording (Fig. 14) from a 6-year-old boy who had feeding difficulties and mental retardation associated with cerebral palsy, yet who had no difficulty with the pharyngeal stage of swallowing. Note that resting respiration continues without change, a condition maintained throughout the test, as he was fed with the spoonful of drink but, as in the normal subject, exhalation consistently followed the period of deglutition apnea. Once the bolus entered the mouth, all timings were normal. It is possible that visual awareness of the approaching spoon was nonexistent and also that there was a lack of tactile awareness on lip/spoon contact.

It is suggested that this period before lip/spoon contact should be regarded in studies of deglutition as an "anticipatory stage," in addition to the established oral, pharyngeal, and esophageal stages of swallowing. It may help, therefore, to record the findings relating to the "anticipatory stage" in the assessment table (Fig. 12) in the space labeled "Other".

We believe that sensory impairments produce disrupted respiratory patterns and that the timing of the disruption may be used as a guide to the identification of the origin of the sensory deficit, the most important of which is the afferent side of the reflex arc, which triggers the pharyngeal stage of swallowing. If this afferent side is defective, neither alteration of respiration nor pharyngeal triggering is possible. Attempts to assess the afferent side by use of the gag reflex test are accepted as unreliable because this reflex is, to some extent, under voluntary control, whereas during the EDAT test any voluntary overriding of reflexly organized rhythms is avoided. EDAT is a test of function (not of structure) and it is possible to use the results to assess more reliably the reflex arc responsible for triggering the pharyngeal stage of swallowing than by testing the gag reflex.

The etiology of impaired oral function during swallowing is complicated by the many factors that coordinate propulsion of the bolus to the back of the mouth. Two distinct abnormal patterns have so far been identified during the oral part of swallowing: consistently prolonged transit times with a much wider variation than usual and respiratory patterns not as consistent as for a normal individual; and multiple swallows per 5 ml spoonful, each swallow being accompanied by normal respiratory patterns whose durations are within defined normal limits.

Poor performance during the oral stage may be due either to predominantly motor nerve pathologic conditions as found in motor neuron disease, producing the pattern described above, or to any combination of the many types of sensory function (e.g., tactile, afferent side of reflex arcs, or proprioception with or without motor weakness) commonly found following a cerebrovascular accident and also in normal subjects who had a topical anesthetic solution applied to the region between the pillars of the fauces, both of which may produce the pattern mentioned above. Even when those neurologic pathways are adequate, poor function that clinically mimics the effects of inadequate neural pathways may be due to other factors such as loss of swallowing memory. Normal EDAT patterns are produced under these conditions when the swallow therapist instructs the patient to swallow the bolus. These additional observations may also be recorded in the summary of the assessment table (Fig. 12). The difficulties with swallowing experienced by a patient appear to be directly related to the number and distribution of the deviations recorded.

Although in patients in whom malfunctioning is occurring EDAT identifies whether any or all of the stages (anticipatory, oral, or pharyngeal) of the swallowing mechanism are involved, sound clinical judgement is required to establish a detailed diagnosis by relating the findings to the clinical examination: for example, poor anticipation while being fed, without prompting the patient, would suggest visual impairment.

The advantages of EDAT in the diagnosis and management of dysphagia of neurological origin are that it is a simple and easily portable piece of equipment; it may be taken to the bedside and used by the swallow therapist; the swallowing may be tested using small amounts of fruit-flavored drink; it is noninvasive, so tests may be performed as often as needed or for research purposes; it appears to be a reliable method of assessing sensory perception during the anticipatory, oral, and pharyngeal stages of swallowing, unaffected by suppression or hyperactivity of the higher centers in the brain; it focuses attention on those stages of the swallowing mechanism in which malfunction occurs and helps to assess the severity of the dysphagia as well as to identify the relative importance of sensory nerve, motor nerve, and functional causes. Combined with other investigative procedures, it helps to formulate a management regimen.

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