A dissection of a manometric trace of the upper esophageal sphincter and the crico-esophageal coordination

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Although manometry is the most accurate method for diagnosing esophageal motility disorders, several patient suffering of high dysphagia remain undiagnosed. Most Authors concentrate their efforts in studying the coordination between the pharynx and the upper esophageal sphincter (UES), while the co-ordination of the UES with the upper esophageal contraction is less studied.
A new method for reading a manometric trace of the UES has been developed, and the crico-esophageal coordination herein is described.

KEY WORDS: Failed antireflux surgery, High dysphagia, Esophageal manometry, Pathophysiology, UES, Zenker,

Introduction

The upper esophageal sphincter (UES) is one of the most important component of the pharyngo-esophageal segment (PES), and is often involved by functional disturbances. The most common symptom is High Dysphagia (HD), or difficulty in initiating the act of swallowing within 1 sec.
The development of HD can be dramatic with severe weight loss and recurrent episodes of aspiration pneumonitis. It is remarkable that even today patients die for aspiration pneumonia without a pathophysiologic explanation, some undoubtedly due to HD. It seems likely that number of these "unexpleined" deaths will rise in the future as the mean age of the population increases, HD being more common in elderly patients.
It is well known that HD arises from central nervous system problems such as deficit of cranial nerves, degenerative diseases, muscle diseases and disorders of the connective tissue [1-3], and finally from gastroesophageal reflux [4] or operations such as an esophagectomy [5].
Although anatomically the UES is located between the pharynx and the esophagus most scientists study only the co-ordination between the pharynx and the UES ignoring the co-ordination with the upper esophageal (UE) contraction [6-9]. The fact that the contraction of the sphincter is still referred to by many different terms, including "closing tone, closing phase, sphincter contraction, postswallow UES contraction etc.", demonstrates the lack of consensus and inconsistency in the evaluation of this phenomenon [9,10].
Herein we review all our cases and describe in detail the new method for reading a manometric trace of the UES

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Material and method

Patients were identified from a prospective maintained database. Nine hundred seventy five patients were identified to have undergone manometric study for functional diseases of the esophagus.

Technique

Manometric studies were performed after an overnight fast with the use of a standard motility catheter consisting of four water-filled polyvinyl tubes bonded together with lateral openings spaced 5 cm apart. The proximal ends of the polyvinyl tubes are connected to pressure transducer and in turn to a polygraph connected to a computer system. A constant infusion of distilled water was delivered by a pneumohydraulic system with an infusion rate of 0.6 ml/min. The station pull-through technique was used to study both esophageal sphincters pressure and relaxations. The esophageal body function was assessed by performance of 10 dry and 10 wet swallows with 5 ml of water every 20 sec. (recording site 5, 10 and 15 cms. above LES).
The probe was then withdrawn into the pharynx using the station pull-through technique while continuous pressure recordings were made. Pressures were recorded with the proximal opening in the pharynx, the middle in the UES zone and the distal one in the upper esophagus. The middle channel, which was oriented anteroposteriorly, was selected for the analysis of the cricopharyngeal sphincter in an effort to minimize recording inconsistencies due to the asymmetry of the sphincter, though we recognize that this does not entirely eliminate such errors. At least one dry and three wet swallows were recorded and evaluated.
Following the manometry, the trace of the upper esophageal sphincter was careful studied, and the method of deduction (a generalization of what the Greek Aristotle philosopher called the syllogism) was used.

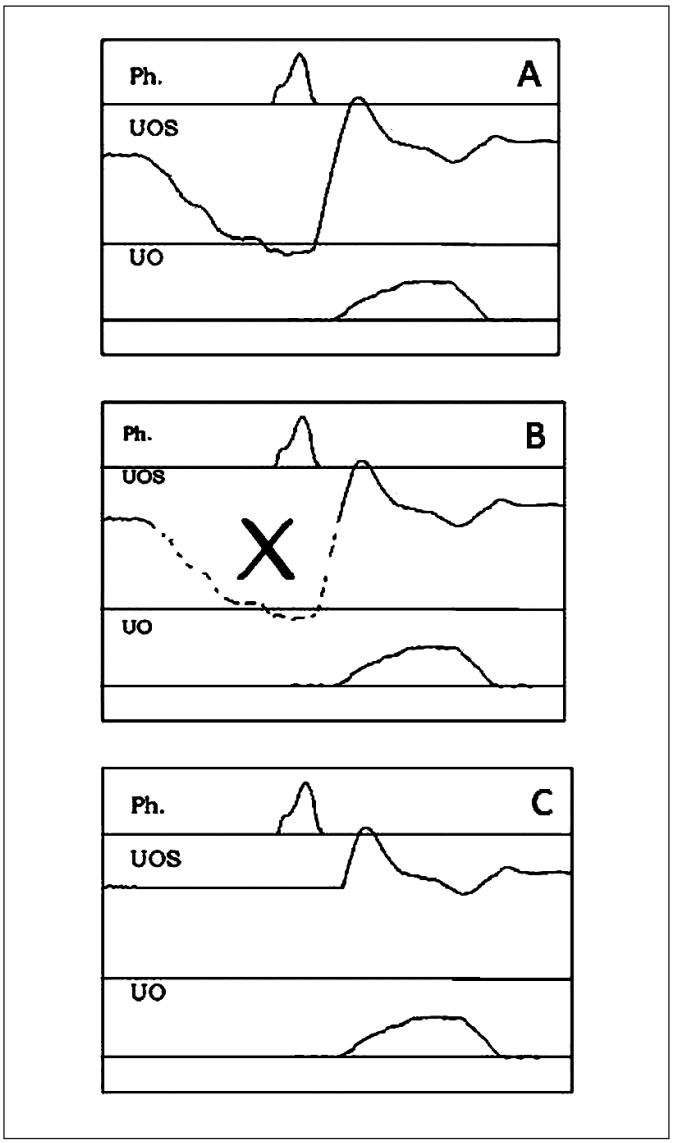

Fig.1 Schematic trace of the UES manometry.
A) normal sequence of the UES zone. There is an adequately coordination between the pharyngeal contraction and the UES opening, and the contraction of the UES is coordinated with the peak of the UE contraction.
B) Method of deduction. When the UES contraction is measured the relaxation phase is already taken away by events and should not be considered. It has been therefore deleted from the schematic trace (X).
C) When the relaxation phase has been deleted from the scheme it appears clear that the so called "closing phase" seems to be a peristaltic contraction through the sphincter.

Result of observations

On manometry the UES shows a two-phase waveform. The first of relaxation (relaxation phase - RP) should be adequately co-ordinated with the pharyngeal complex and is normal when it occurs before the onset of the pharyngeal contraction [3] (Fig. 1a). The second phase of contraction (closing phase - CP) represents the contraction that pushes the bolus down into the esophagus, and it is normal when the peak of UES contraction precedes the peak of the UE contraction (Fig. 1a).
When the UES contraction is studied the relaxation phase is already taken away by events and should not be considered, and therefore it has been deleted from the schematic trace (Fig. 1b). In Fig. 1c (where the relaxation phase has been deleted) it appears clear that the so called "closing phase" seems to be a peristaltic contraction through the sphincter.
Patients with diagnosis of functional disorders of the UES associated with an alteration of the coordination between the CP and the UE contractions have already been published as shown in the Table I [11-15]. The type of reported manometric alterations are in Table II.

TABLE I - *Evidence table in 46 patients published in the literature with crico-esophageal incoordination*

Reference n°	N. Patients	Diagnosis
10	12	Zenker
11	14	HD
12	2	Tight Nissen
14	18	Achalasia

TABLE II - *Types of reported motility abnormalities resulting in a crico-esophageal coordination. CT: closing tone of upper esophageal sphincter. UE: upper esophageal.*

High CT amplitude
Long duration of CT
Simultaneous contraction between CT and UE contraction
Normal amplitude and duration of CT but absence of UE contraction

Discussion

The deglutition is a fascinating aspect of human physiology, under central nervous control with an unknown clear mechanism. A neuromuscular abnormality of the pharyngo-esophageal segment may lead to the development of HD; several hypothesis have been put forward to explain the HD, but reported abnormalities have not always been verified by independent groups.
Hyperdynamic UES was also found in patients with globus sensation [15].
The relationship between the pharynx, the upper esophageal sphincter and the upper esophagus is not a new finding; in fact it has been demonstrated using different methodologies such as histochemical analysis [16], biomechanical markers [17], electromyographic study [18], and using combined manometry and videofluoroscopy [19]. Recently by using a concurrent US and manometry study it has been demonstrated the upper esophagus to be a significant contributor to the distal UES high pressure zone [20].
The manometric finding of crico-esophageal inco-ordination in patients with Zenker's diverticulum and a new classification of the pharyngo-esophageal motility disorders, on the basis of observed abnormalities, namely pharyngeal (pre-sphincteric), sphincteric and esophageal (post-sphincteric) disorders have been previously reported [9-11]. We have also demonstrated a strong correlation between the pharyngeal contraction and the CP; also we confirmed that the HD, in some circumstances, can suggest a functional disorder of the lower esophagus such as in patients with tight Nissen [12,13]. Even more, the fact that HD was present during the first phase of the natural history of esophageal achalasia (EA) suggested that all patients referred for HD should be investigated for EA [14].
Although three different types of probes have been used to study the motility of the PES (perfused, sleeve, solid state), the schematic representation of the pharyngo-esophageal motility is identical, therefore the following discussion can be applied to the different groups.
One question that requires an explanation is: what does the CP represent?
There are at least three possibilities. The *first* is that the "closing phase" represents a sphincteric contraction to allow propulsion of the bolus into the esophagus, and it clearly must be co-ordinated with the UE contraction. The *second* could be due to the axial excursion of the probe, a known source of inaccuracies. It is not a sphincteric contraction but represents a pharyngeal or esophageal contraction: even in these circumstances the CP should be co-ordinated with the UE contraction. It is known infact that the UES is mobile, making approximately a 0.5-cm excursion during swallowing. This movement will displace the sensor from the high pressure zone. Although sample measurements can be made by pulling a focal sensor through the sphincter, such movement of the assembly irritates the pharynx and can increases UES pressure 21.
The *third* possibility is illustrated by the manometric traces in Fig. 1: the CP seems to be the propagation of the pharyngeal contraction through the UES (Fig. 1c). The CP may be interpreted as a *transphincteric contraction.* Alterations in the co-ordination of the transphincteric contraction with the UE wave may explain in part some functional disorders of the PES[10] (Table II).
The presence of HD after esophagectomy in absence of an anastomotic stricture is not uncommon [5], and no consistent motility patters have been demonstrated [22,23], we speculate that the possible cause of HD at the anastomotic site could be the absence of motility co-ordination between the closing tone of the UES and the esophageal substitute such as stomach or colon.
The reported data suggest that primary esophageal peristalsis should not be considered as an independent event but as a coordinated sequence of events in which there may be a well synchronized progression of contraction starting in the pharynx going through the UES into the esophagus.
Further investigate work may be required to confirm the advantages and the potential shortcoming of this manometric method to study the UES over the classic method.
In conclusion, when studying the motility of the UES, in order to obtain a more precise understanding on the upper esophageal sphincter disorders is mandatory to study the co-ordination of the "closing phase of the UES" with the esophageal contractions.

Riassunto

Sebbene la manometria rappresenti il metodo più naturale per diagnosticare le alterazioni della motilità esofa-

gea, molti pazienti affetti da disfagia alta rimangono senza diagnosi. La maggior parte degli Autori concentra i suoi sforzi per studiare la coordinazione tra faringe e sfintere esofageo superiose (UES), mentre viene meno studiata la coordinazione tra UES ed esofago superiore (UE). È stato dunque sviluppato un nuovo metodo per leggere il tracciato manometrico del tratto faringo-cricoesofageo, ed esso viene qui descritto.

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