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ORIGINAL ARTICLE

Dysphagia in acute tetraplegics: a retrospective study

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Study design: Retrospective study.
Objectives: Swallowing disorder in patients with tetraplegia represents a problem. Incidence and clinical data were examined to determine the influencing factors.
Setting: Level I trauma Center, Berlin, Germany.
Method: Retrospective study (1 September 1997–31 December 2002) on hospitalized patients with acute tetraplegia. The patients' swallowing ability was examined both clinically and endoscopically, and the results correlated with clinical data.
Results: A total of 175 patients (144 (82.29%) male patients and 31 (17.71%) female patients (4.6:1) were studied. The peak age groups (43.45, ±18.98, 14–89 years) were 20–30 years and over 60 years. C4–C6 were most commonly affected. Tetraplegia was trauma-related in 147 (84%) patients. Twenty-eight (16.0%) patients appeared to be suffering from a swallowing disorder on first feeding, 23 (82.14%) patients with dysphagia were tracheotomized. The level of tetraplegia ($\chi^2=19.8$; $P<0.05$), tracheotomy ($\chi^2=21.7$; $P<0.05$) and the duration of ventilation ($\chi^2=24.84$, $P<0.05$) were all found to be statistically significant factors in the development of a swallowing disorder. Age, surgical approach, level of tetraplegia, severity of paralysis and the need for tracheotomy were predictive of dysphagia in 73.14% patients. Five patients with dysphagia died (because of causes other than dysphagia) and 10 patients were discharged with a feeding tube.
Conclusion: No single trigger for a swallowing disorder in acute tetraplegia was found. A combination of multiple factors (level of tetraplegia, severity of paralysis, tracheotomy, accompanying injuries and accompanying illnesses) restricts swallowing and compensation of changes, to the extent that a swallowing disorder becomes apparent.
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Keywords: dysphagia; tracheotomy; tetraplegia; complication; therapy

Introduction

Injuries to the cervical spine occur in an area where the swallowing process can be significantly influenced by anatomical and physiological changes. The proximity of the larynx, oesophagus and spine mean that irritation in this area can lead to swallowing disorders, and aspiration of saliva and food. The other factor is the treatment required for injuries to this area. Bone injuries with accompanying injury to the spinal cord will usually require surgical treatment. The incidence of swallowing disorders after cervical spine surgery via an anterior approach is reported to be high. Whitecloud[1] describes swallowing disorders as the most common complication. Cloward[2] reports swallowing disorders in 80% of patients who undergo surgical treatment. Other studies have reported a lower prevalence.[3,4] In a 1987 retrospective study of the incidence of swallowing disorders in 160 patients with tetraplegia,[5] a swallowing disorder was observed in 20% of patients in the first 4 months post-injury and 13% of patients thereafter. These always occurred in cases of complete paraplegia.

Tracheotomy required as a result of the severity of the illness and the necessity for mechanical ventilation was a further influencing factor. Various previous studies have identified a correlation between tracheotomy and dysphagia in tetraplegic patients.[6,7] We carried out a retrospective study to examine swallowing ability after injuries to the cervical spine involving injury to the spinal cord and its possible causes and correlates.

Materials and methods

A retrospective study was carried out by examining the medical records of all patients admitted to the spinal cord injuries unit at the Unfallkrankenhaus in Berlin between 1

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September 1997 and 31 December 2002 after an injury between the cranio-cervical junction and the first thoracic vertebra. All patients who had sustained this spinal cord injury within the previous 8 weeks and who had undergone continuous in-patient treatment since the injury was included in the study. The study was approved by the institutional ethics committee. A written declaration of consent to scientific analysis of the data was obtained.

The level of the lesion was determined using the American Spinal Injury Association Grading Scale (ASIA). Functional severity was determined internationally using the Frankel's score. On admission, patients were examined by a doctor from the treatment center for spinal cord injuries.

All patients whose paralysis was found to be caused by a constriction of the vertebral canal underwent immediate surgery. Patients were admitted to the intensive care unit for stabilization of their vital signs, or for monitoring after surgery or transfer from another institution.

All patients were examined with a clinical bedside bolus-swallowing test by a speech therapist (SLT) before commencing oral feeding. An endoscopic-swallowing test using a standardized examination protocol was also carried out by an Ear Nose and Throat doctor and was used to determine whether swallowing therapy should be given.[8] The required therapeutic measures were determined by an interdisciplinary team.

Data collected were encoded, and an absolute and relative frequency distributions analyzed. Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS 11.0). Frequency, means and standard deviations were determined. Correlations within the data were tested in a cross tabulation with the χ^2 test at a significance level of $P<0.05$. Comparison between groups was carried out using the nonparametric Kruskal–Wallis H test. The null hypotheses, that there is equality between the groups, was rejected if the calculated test statistic was greater than or equal to the χ^2 value for the degrees of freedom and the significance level was 5%. Discriminant analysis was used to determine which factors had influenced the need for tracheotomy. The percentage value of the exact analysis was entered.

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Results

Patients

In all, 185 patients were treated between 1 September 1997 and 31 December 2002. Out of which, 175 patients whose complete data was available were included in the analysis. 144 (82.29%) of the 175 patients were male and 31 (17.71%) female patients. The age ranged from 14 to 89 (mean = 43.45 ± 18.98). Men were affected more frequently than women (4.6:1), with similar age profiles for both sexes (see Table 1).

A total of 147 patients (84%) suffered paralysis as a result of trauma. Seventy-three patients (41.71%) had a fracture of the vertebral body. Forty-seven patients (26.86%) had two fractured vertebrae and 16 patients (9.14%) had fractures of more than two cervical vertebrae (see Tables 2 and 3).

In all, 70 (47.6%) of the 147 patients with traumatic cervical injuries had accompanying injuries. Thirty-one patients (21.1%) had one, 12 (8.2%) had two and 9 patients (6.1%) had three accompanying injuries, 7 patients (4.8%) had four and 11 patients (7.5%) five accompanying injuries. No accompanying injuries were identified in 77 patients (52.4%). Seventy patients (40%) were suffering from one or more existing disorders on admission.

Table 1 Gender and level of injury

Level	*All*	*Men*	*Women*
C0	1 (0.57)	1 (0.69%)	0 (0.00%)
C1	1 (0.57)	1 (0.69%)	0 (0.00%)
C2	4 (2.29)	2 (1.39%)	2 (6.45%)
C3	14 (8.00)	13 (9.03%)	1 (3.23%)
C4	58 (33.14)	48 (33.33%)	10 (32.26%)
C5	53 (30.29)	42 (29.17%)	11 (35.48%)
C6	33 (18.86)	28 (19.44%)	5 (16.13%)
C7	6 (3.43)	5 (3.47%)	1 (3.23%)
C8	5 (2.86)	4 (2.78%)	1 (3.23%)

The table shows number and frequency of the level of injury.

Table 2 Etiology of quadriplegia

Etiology	*Number*
Fracture 1 vertebral body	73 (41.71%)
Fracture 2 vertebral bodies	47 (26.86%)
Fracture >2 vertebral bodies	16 (9.14%)
Spondylodiscitis	15 (8.57%)
Contusio spinalis	10 (5.71%)
Tumor	5 (2.86%)
Spinal stenosis	4 (2.29%)
Nucleus pulposus prolaps	3 (1.71%)
Knife wound	1 (0.57%)
Postoperative	1 (0.57%)

The table shows number and percent of the aetiologies ($n=175$).

Table 3 Level of tetraplegia

Frankel	*Number*
TA	103 (58.86%)
TB	19 (10.86%)
TC	21 (12.00%)
TD	24 (13.71%)
TE	8 (4.57%)

The table shows number and frequency of the Frankel's score ($n=175$).

Operative treatment

A total of 163 patients (93.14%) were initially treated surgically, in 134 cases (80.24%) by a ventral approach, in 22 cases (13.17%) by a dorsal approach and in 7 cases (4.19%) by a combined dorso-ventral approach. Forty-nine patients (30%) required a second operation. In 35 patients

(71.42%), this was because of continuing instability after initial treatment (see Table 4).

Intensive treatment

In all, 123 patients (70.85%, $n=175$) were treated in the intensive care unit during their admission. The duration of intensive treatment averaged 17.81 ($\pm$24.05; 1–177) days. Eighty-nine patients (50.86%, $n=175$) had a single episode of intensive treatment (mean = 11.3 days), with 29 patients (16.57%, $n=175$) undergoing two episodes of intensive treatment for a mean total of 32.63 days. The duration of intensive treatment correlated with the duration of ventilation ($\chi^2=120.83$, $P<0.05$), tracheotomy ($\chi^2=90.57$, $P<0.05$) and was dependent on the Frankel's score (H test = 16.23, $P=0.022$). In the patients whose paralysis had a non-traumatic origin, there was also a correlation between the number of accompanying illnesses ($\chi^2=90.63$, $P<0.05$) and the level of tetraplegia ($\chi^2=100.03$, $P<0.05$).

Swallowing disorders

Swallowing disorders were identified in 28 (16.0%) of the 175 patients with cervical cord injuries examined (see Table 5). No statistically significant correlation between age or sex and the frequency of occurrence of swallowing disorders was observed. Swallowing disorders were most frequent in patients with the highest grade of sensorimotor deficit, though the effect was not statistically significant ($\chi^2=6.5$; $P>0.05$). The level of tetraplegia had a statistically significant effect on the development of dysphagia ($\chi^2=19.8$; $P<0.05$), with the number of swallowing disorders increasing as the level of tetraplegia lowered (see Figure 1).

A ventral approach was used during surgery in 18 of the patients with swallowing disorders (64.29%; $n=28$), with a dorsal or combined approach used in the remaining patients. Patients in whom a posterior or combined approach was used had a disproportionately high rate of swallowing disorders, but this was not found to be statistically significant ($\chi^2=3.35$; $P>0.05$) (see Table 4).

A total of 23 patients with swallowing disorder (82.14%; $n=28$) were tracheotomized. Tracheotomy ($\chi^2=21.7$; $P<0.05$) and duration of ventilation ($\chi^2=24.84$ $P<0.05$) were confirmed as having a statistically significant effect on the development of a swallowing disorder. No other statistically significant factors were identified.

On examining the prediction probability, age, operative approach, level of tetraplegia, severity of paralysis and a tracheotomy were found to predict dysphagia in 73.14% patients (see Table 6).

The prognosis for patients with tetraplegia and dysphagia was fair. Five patients (17.86%; $n=28$) died at the time of their admission, in all cases not as a direct consequence of dysphagia. Ten patients (35.71%; $n=28$) were unable to meet their full nutritional needs orally on discharge and were discharged with a feeding tube.

Table 4 Operative treatment and dysphagia

Approach	*Normal swallowing (n = 147)*	*Swallowing disorder (n = 28)*
None	9 (6.12%)	0 (0.00%)
Anterior	104 (70.75%)	18 (64.29%)
Posterior	13 (8.84%)	4 (14.29%)
Combined	21 (47.62%)	6 (21.43%)
Brace		
Miami-J-collar	77 (52.38%)	14 (50.00%)
None	70 (47.62%)	14 (50.00%)
Halo-frame		
Halo-frame	11 (7.48%)	3 (10.71%)
None	136 (92.52%)	25 (89.29%)

The table shows the operative treatment and the swallowing disorders. No statistical correlation was found between operative treatment and dysphagia.

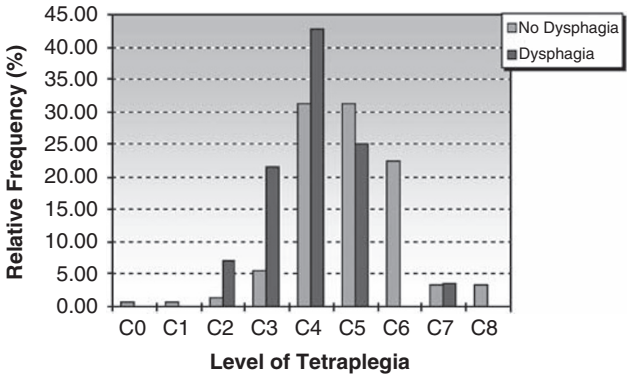

Figure 1 Dysphagia and level of tetraplegia. The figure shows the relative frequency of dysphagia for different levels of tetraplegia ($n=175$).

Table 5 Results of swallowing tests

Endoscopy	*First attempt (n = 175)*	*Second attempt (n = 175)*	*Third attempt (n = 175)*
No abnormalities	147 (84%)	14 (50.00%)	9 (52.94%)
Penetration with coughing	8 (4.57%)	3 (11.11%)	0 (0.00%)
Aspiration with coughing	7 (4.00%)	3 (11.11%)	2 (11.76%)
Aspiration without coughing	13 (7.43%)	7 (25.93%)	6 (35.29%)
Clinical findings			
Pain/bolus sensation	7 (4.00%)	6 (22.22%)	4 (4.82%)
Declined food	0 (0.00%)	2 (7.4%)	0 (0.00%)

The table shows the results of the clinical and endoscopic examinations. The initial examination was carried out prior to commencing oral feeding.

Table 6 Prediction probability of dysphagia

Factors	*Probability (%)*
Age	58.86
Level of tetraplegia	49.14
Frankel's score	62.29
Tracheotomy	68.00
Age, level of tetraplegia, Frankel's score	66.29
Age, level of tetraplegia, Frankel's score, number of accompanying illnesses	69.14
Age, level of tetraplegia, Frankel's score, number of accompanying illnesses, tracheotomy	70.86
Age, level of tetraplegia, Frankel's score, tracheotomy	71.43
Age, level of tetraplegia, Frankel's score, tracheotomy, approach	73.14

The table shows the prediction probability for a tracheotomy with various clinical factors and combinations of factors.

Discussion

Dysphagia in tetraplegic patients represents a complication necessitating treatment. A swallowing disorder may result in pneumonia, which can have fatal consequences in already seriously ill patients. To date, there have been few studies on large patient populations being examined on this issue. Those studies, which have been carried out, have been retrospective and have collected potential trigger factors. Kirshblum *et al*.[6] showed that, in addition to factors such as age, surgical approach and ventilation, tracheotomized patients had a particularly high risk of developing swallowing disorder. A study by Abel was able to confirm, with the exception of age, the effect of these factors. In addition, the authors have recorded a correlation between the duration of intubation and the occurrence of dysphagia.[7] Wolf,[5] by contrast, was unable to find any correlation between dysphagia and the level of tetraplegia. In their study, the level of tetraplegia did, however, affect the outcome on discharge. That study also showed a correlation between tracheotomy and swallowing disorders.

Many studies have recorded a correlation between an anterior surgical approach and the occurrence of swallowing disorder.[2,3,7,9] This correlation was not observed in our study, in which the posterior and combined approaches were more frequently accompanied by swallowing disorders. As mechanical alteration of the tissues during an anterior approach has repeatedly been described as the mechanism for dysphagia, a different treatment of the tissues must be the reason for the improved results in our population. Problems during the surgical procedure must be considered in Wolf's study,[5] in which the cause of dysphagia was, in all cases, identified as laryngeal swelling. Such swelling generally arises due to a lack of lymphatic or other drainage as a result of trauma. This trauma may arise from the original accident or during surgical treatment.

In their study, Martin *et al*.[9] have stated that oral functional impairments can be identified as triggers for swallowing disorders. They suggest that injuries to the hypoglossal nerve may represent one trigger factor. Buchholz[10] suggested that oral functional impairments arise as a result of injuries to the hypoglossal nerve and are not the result of injury to the cervical spine, but must instead be triggered as a result of additional injuries, to, for example, the brain stem. This idea was examined in a study by Abel *et al*.[7] They were unable to find a correlation between head injury and swallowing disorders This was confirmed in our own investigations.

Various researchers have postulated that irritation to the superior laryngeal nerve as a result of trauma and surgical revision may trigger sensory impairment.[9] Buchholz[10] rejected this hypothesis, with the argument that both nerves would need to be destroyed for this to trigger a swallowing disorder. He postulated changes in pharyngeal wall sensitivity as a result of the separation of the rear wall of the pharynx for surgery. The most common injury site is, however, at the C4–C6 level and, thus, behind the larynx. Sensory impairment in this area is no longer greatly relevant to the swallowing process. Impairment to the pharynx's propulsive wave would be a more productive point of discussion.

Gross *et al*.[11] examined in different studies the value of the respiratory volume and the subglottic pressure resulting from it at a normal swallow. The reduction of these factors due to a tracheotomy tube or a thorax trauma raises the risk of an aspiration. The risk profiles for a dysphagia in acute tetraplegia suggest an influence to this hypothesis.

The results of the present study suggest that no single factor is the cause of swallowing disorders. Only in individual cases were, for example, changes resulting from surgery identifiable as the cause of a swallowing disorder.[12] In most cases it is a combination of various clinical factors, which lead to a significant swallowing disorder.

The statistically significant effect of tracheotomy on swallowing disorders in tetraplegia also requires assessment. A study on the necessity of tracheotomy in the same patient population showed that the severity of illness (level of tetraplegia and Frankel's score) and the number and severity of accompanying injuries (in particular, thoracic injuries) and accompanying illnesses was critical to the necessity of tracheotomy. In none of the cases examined was dysphagia the trigger for tracheotomy.

Swallowing is a complex process, which is influenced by a range of factors. To be regarded as safe, a swallow must protect the lower respiratory tract from aspiration. Protection of the lower respiratory tract is influenced by the ability to swallow and the ability to deal with and cough-up a failed swallow. These abilities are founded on adequate vigilance, strength, motor function and coordination. In the event of an injury to the upper cervical cord, the patient will, as a result of paralysis, lose large components of the ability to swallow safely (see Figure 2). Should changes to the pharynx occur as a result of tetraplegia and its treatment in the form of swelling, changes to sensitivity, motor function or laryngeal elevation, the patient must attempt to compensate for these changes. Various options for achieving this compensation are available and are tested unconsciously by an awake patient, who will adjust his or her head position, posture or the consistency of his or her food, and so on. The loss of muscle tone as a result of tetraplegia means that a change in posture is not possible. Likewise, as a result of surgical fixation and, in some cases, additional external

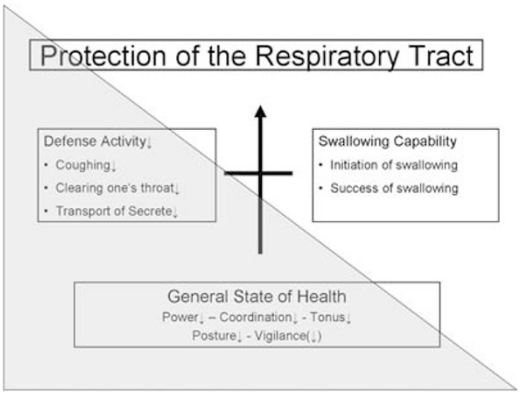

Figure 2 Tetraplegia and protection of the respiratory tract. Schematic representation of the restrictions (gray, arrows) experienced by a patient with tetraplegia in protecting the respiratory tract during swallowing.

stabilization (halo fixation, Miami-J-collar, and so on), adjustment of head position. Most patients with a fixation collar are able to swallow without difficulty. There are, however, patients who are sufficiently restricted by a neck brace that this factor becomes more significant.[13] The ability to compensate a dysphagia is determined by individual abilities and factors such as the patient's age, level of tetraplegia and sensorimotor deficit. These are the clinical parameters found to be predictive for dysphagia in our own investigations.

One criticism to which this and previous studies can be fairly subjected is that the number of patients with dysphagia is low for a statistical analysis. Statistically significant statements on triggers for swallowing disorders are therefore impossible. At the same time, the retrospective nature of the study makes a structural analysis of causality more difficult, as it is not possible to measure potential parameters (pharyngeal sensitivity, electromyography of the musculature involved in swallowing) retrospectively.

The first oral feeding of patients with acute tetraplegia should be started after a standardized clinical swallowing test by an SLT. At suspicion of a dysphagia an endoscopic swallowing evaluation can complete the diagnostics. In the case of dysphagia it is the task of the SLT to restore the oropharyngeal biomechanics with the objective of a structured oral feeding. An interdisciplinary tracheotomy management is necessary to restore the natural respiratory tract.

Swallowing disorders require intensive rehabilitation measures, as the prognosis for a swallowing disorder in a patient with tetraplegia is not good. A fifth of patients with swallowing disorder die and a third require long-term use of a feeding tube. Treating patients with a swallowing disorder implies a substantial financial burden. The increase in length of stay by 73 days (with no dysphagia 182.56 ± 124.02, 1–549; with dysphagia 255.64 ± 186.69, 32–660) gives rise to additional costs of €40.000 for in-patient treatment.

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