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Speech-language Pathology Rehabilitation in a Case of Jefferson Fracture Complicated with Lower Cranial Nerve Palsies

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Abstract

A 68-year-old man presented with a Jefferson fracture leading to lower cranial nerve palsies affecting the ninth, tenth, and twelfth cranial nerves with a traumatic basilar impression. On the X day, the patient underwent occipitocervical posterior fixation surgery; the surgery was uneventful. However, just after the surgery, epipharyngeal palsy and airway obstruction occurred. Consequently, tracheostomy was needed. On the X+8 day, speech-language pathology (SLP) therapy was initiated for decannulation. On the X+21 day, the patient could clear all the checkpoints and was decannulated. On the X+36 day, the patient was discharged home and SLP therapy was continued. On the X+171 day, his SLP therapy was halted. However, the patient continued to complain that he could not speak as fast as before, and his quality of life remained compromised. Some studies reported that lower cranial nerve palsies affecting the ninth to the twelfth cranial nerve occur in conjunction with Jefferson fractures. Thus, SLP therapy is crucial for Jefferson fracture cases.

Keywords: Jefferson fracture, traumatic basilar impression, occipitocervical posterior fixation, rehabilitation for decannulation, dysarthria

Introduction

A Jefferson fracture is a burst fracture of the atlas, and some reports have stated that its clinical symptoms are likely to be mild.[1)] However, lower cranial nerve palsies affecting the ninth to twelfth cranial nerves or Collet-Sicard syndrome may occur after Jefferson fractures.[2-4)]

Lower cranial nerve palsies affecting the ninth to twelfth cranial nerves adversely affect movements and sensations of the tongue, pharynx, and larynx. These impairments may cause dysarthria and dysphagia.

We believe that cases of Jefferson fracture with lower cranial nerve palsies need speech-language pathology (SLP) therapy. However, to date, there are no reports regarding the efficacy of SLP therapy for Jefferson fractures with lower cranial nerve palsies. We report a case of a Jefferson fracture and traumatic basilar impression with lower cranial nerve palsies that required SLP therapy for decannulation, dysphagia, and dysarthria. The progress of the patient's SLP rehabilitation is detailed below.

Case Report

A 68-year-old man suffered from dyspnea and dysphagia after a skiing accident. The patient had no past medical history. Three days later, the patient visited our hospital and was admitted because of a Jefferson fracture and basilar impression revealed during the XP, CT, and MRI of the craniocervical junction (Fig. 1). After hospitalization, lower cranial nerve palsies involving the ninth, tenth, and twelfth cranial nerves were observed. The gap in the fractured anterior arch of the atlas was over 5 mm, and CT sagittal images showed a basilar impression. The tip of the odontoid process was located above the Chamberlain's line (a line from the hard palate to the base of the skull). Furthermore, strong radiating pain occurred when swallowing

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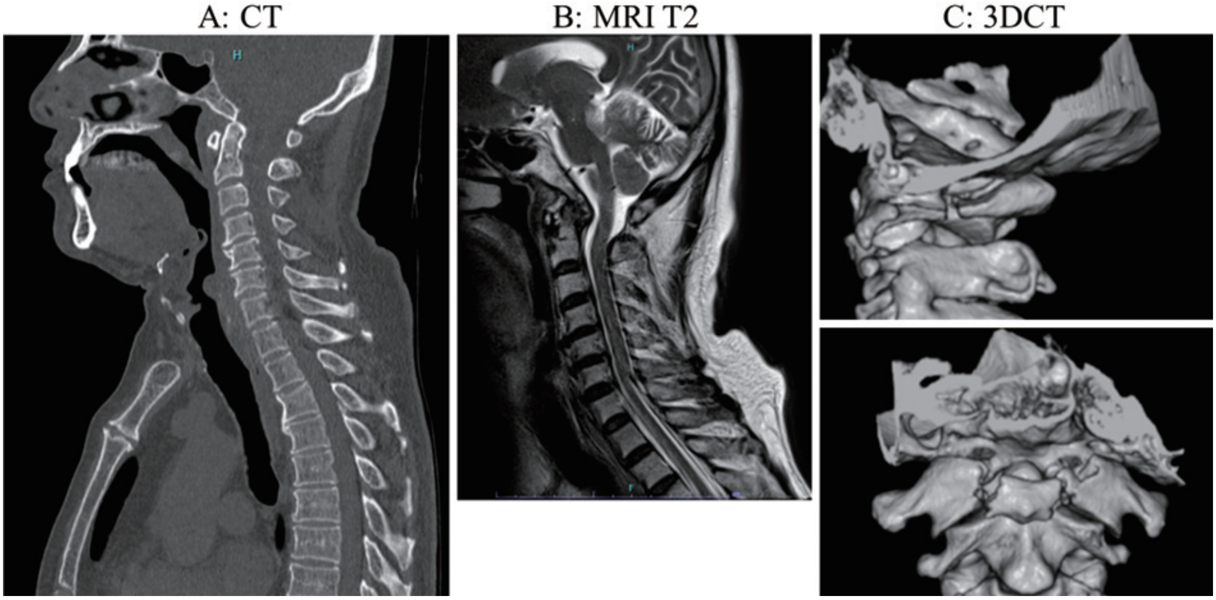

Fig. 1 CT MRI 3DCT.
The gap in the fractured anterior arch of the atlas was more than 5 mm, and the CT sagittal images showed a basilar impression. The tip of the odontoid process was located above the Chamberlain's line (a line from the hard palate to the base of the skull).
CT; Computed Tomography, MRI; Magnetic Resonance Imaging, 3DCT; Three-dimensional Computed Tomography

from the pharynx to the larynx. The pain and the dysphagia made food intake extremely difficult. As bone fusion was expected to be unlikely by external fixation with a halo vest, a posterior fixation surgery was performed.

On the eleventh day after the accident, occipitocervical posterior fixation was performed (day X). The O-C2 angle was kept approximately 5 degrees wider than the preoperative O-C2 angle to prevent postoperative dysphagia and dyspnea, and the basilar impression was slightly reduced. The surgery was uneventfully; however, pharyngeal palsy and airway obstruction occurred. Consequently, tracheostomy was performed using a single-lumen cuffed tracheostomy tube.

On the X+2 day, bradyesthesia and bradykinesia of his epipharynx and hypopharynx were found with a nasopharyngeal fiberscope, and tube feeding with a nasogastric tube was initiated.

On the X+8 day, SLP therapy was started for tracheostomy decannulation. The conditions for decannulation (Table 1) were assessed using the "Multidisciplinary decision chart for evaluating readiness for decannulation used in the Rehabilitation Basel"[5] (Table 1-A), the "Decannulation Protocol Checkpoint"[6] (Table 1-B), and the Mann Assessment of Swallowing Ability (MASA; the assessment measures twenty-four different areas to gage the swallowing ability, highest possible score being 200).[7,8] In our patient, pharyngeal and swallowing reflexes were absent. He had dysphagia, velopharyngeal incompetence, vocal fold palsy, and hypoglossal nerve palsy. The strength of the sternocleidomastoid and trapezius muscles was difficult to assess because of pain. The patient did not show any facial sensory disturbance. The patient's MASA score was 94/200, indicating severe dysphagia.

On the X+8 day, training was initiated to induce vocalization by injecting air from the side tube (the side tube is used for vocal practice and suction of deposits on the cuff) using a 50-cc syringe. On the X+10 day, the patient could utter vocal sounds using the training tube. He could clear the 1st, 2nd, 5th, 8th, and 9th SLP criteria, all of the Nurse criteria, and the 1st-to-3rd Physician criteria of the "Multidisciplinary decision chart for evaluating readiness for decannulation used in the Rehabilitation Basel"[5]; hence, the decannulation protocol proceeded to training under cuff-deflation. Moreover, on the X+12 day, the swallowing reflex improved and the MASA score increased to 115/200. The tracheostomy tube was changed to a double-lumen, fenestrated cuffed tube, and the decannulation advanced to the step of tube occlusion with a one-way valve. On the X+14 day, the patient was able to extend his tongue to the upper lip, and pharyngeal reflex appeared. The patient was able to breathe using a one-way valve during the day. On the X+17 day, his cough reflex improved and the MASA's score increased to 142/200; moreover, the patient could clear all the "Multidisciplinary decision chart for evaluating readiness for decannulation used in the Rehabilitation Basel"[5] criteria with the deflated cuff; hence, tube occlusion training was initiated. On the X+21 day, the patient could clear all the criteria on the "Multidisciplinary decision chart"[6] during tube occlusion intervals. The patient

Table 1 The decannulation conditions

Table 1-A: Multidisciplinary decision chart for evaluating readiness for decannulation used in the rehabilitation basel[5]	**Table 1-B: Decannulation protocol checkpoint**[6]
Speech Language Pathologist criteria: 1 Patient can be positioned upright, on the side, or in prone position so that saliva can be swallowed or let drool 2 Cleaning of oral tract and teeth is possible 3 During cuff deflation intervals, only minimal secretions from above the cuff have to be suctioned 4 During cuff-deflation and tube-occlusion intervals, the patient can breathe spontaneously and sufficiently through the upper airway for a minimum of 20 min with sufficient and stable oxygen saturation (minimum 95% ±5%) 5 Patient can swallow his secretions spontaneously or with light stimulation 6 Efficient spontaneous coughing with subsequent swallowing 7 Improved vigilance 8 Exclusion of reflux and frequent vomiting 9 If necessary, fiberoptic endoscopic evaluation of swallowing (FEES) Nurse criteria (in addition to Speech Language Pathologists criteria): 1 Decreasing need for tracheal suctioning 2 Secretions are liquid and whitish 3 Patient tolerates a mask for respiratory assistance if necessary 4 Positioning to support respiration and secretion management is possible 5 No anesthesia/operations planned for the following week Physician criteria (in addition to Speech Language Pathologists and Nurses criteria): 1 No acute pulmonary complications, no atelectasis 2 If necessary, evaluation of patency of the upper airway 3 Evaluation of further specific medical contraindication	SaO2 > 92 % on breathing room air Effective cough with reduction in and/ or ability to self-manage secretions Absence of infections No significant abnormalities at the chest X-ray At least partial swallowing effectiveness Absence of obstruction of the upper respiratory tract Satisfactory nutritional conditions
Table 1-A: Decannulation decision chart for weaning dysphagic patients from the tracheostomy tube.	Table 1-B: The procedure aimed at assessing the patient's ability to breathe through own glottic plane. it also provides indirect information on tracheal patency.

met the "Decannulation Protocol Checkpoint"[8] and was cleared for decannulation. The patient's MASA score increased to 160/200.

On the X+23 day, the swallowing function gradually recovered, and the swallowing reflex to water became also reliably triggered. The nasogastric tube was removed and the patient could consume soft and bite-sized foods. The patient's tongue deviated to the left, so we conducted the nonspeech oral motor exercise. On the X+36 day, the patient could easily chew food and was discharged home. SLP therapy was continued at our clinic. On the X+45 day, the patient could eat regularly, and the MASA score increased to 191/200, which meant that there was no dysphagia.

On the X+46 day, the patient was able to speak clearly enough that a normal listener could easily understand. Moreover, the speech rate of text and the oral diadochokinesis[9] were normal. However, the patient complained that he could not speak as fast as before. The alternating repetitive movements of his tongue presented incoordination of movement, thus SLP therapy was continued. On the X+171 day, the patient was able to speak more clearly than on the X+46 day. However, the patient complained of his unrecovered speech rate and his leftward tongue deviation. Fig. 2 shows the progression of the patient's speech rates, alternating repetitive movements, and oral diadochokinesis.

Discussion

About the appearance of his lower cranial nerve palsies

The patient presented with a Jefferson fracture causing lower cranial nerve palsies with a traumatic basilar impression. However, the patient did not have any disturbances in the first to eighth cranial nerves. The patient presented with the absence of pharyngeal and swallowing reflexes, dysphagia, velopharyngeal incompetence, vocal fold palsy, and hypoglossal nerve palsy due to palsies of the ninth, tenth, and twelfth cranial nerves. Some reports have stated that lower cranial nerve palsies or Collet-Sicard syndrome may occur in conjunction with Jefferson

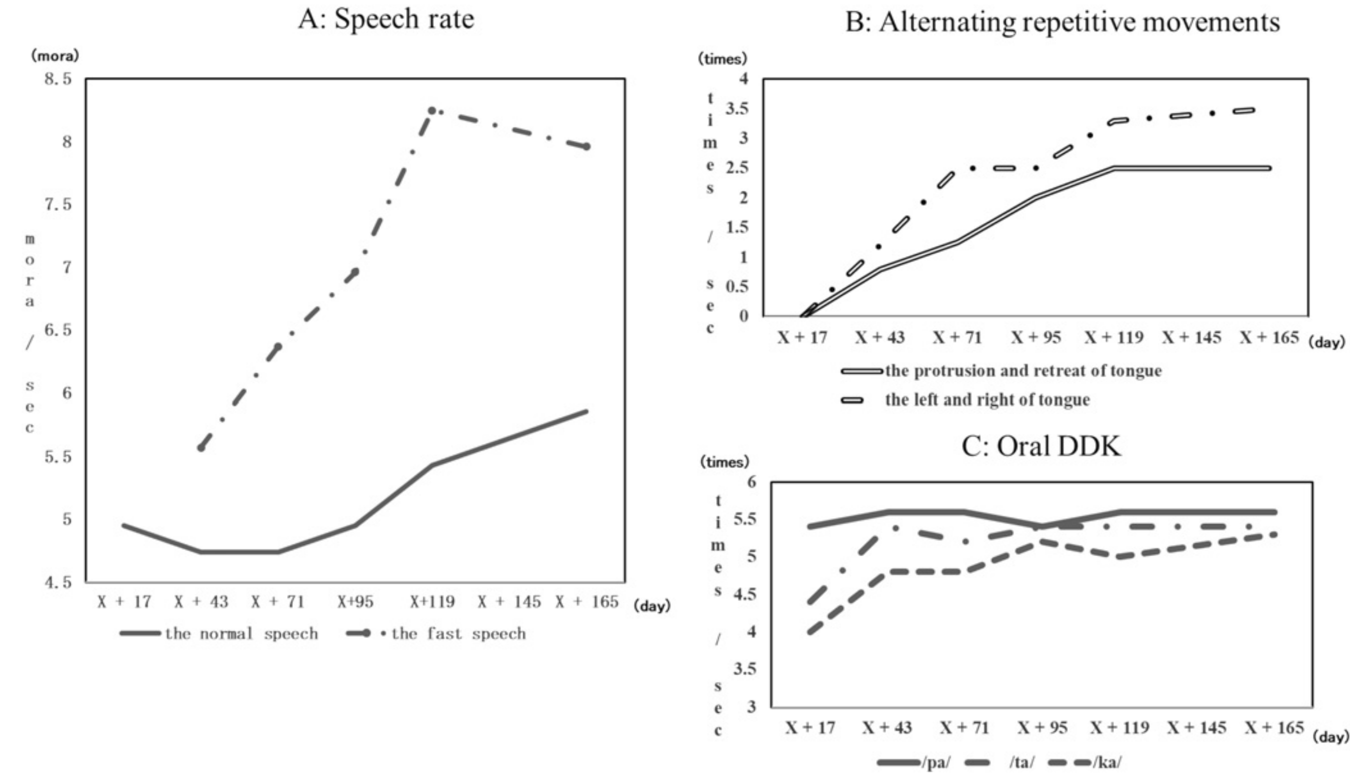

Fig. 2 Course of recovery in the speech rates, alternating repetitive movements, and oral diadochokinesis.
Fig. 2-A shows recovery of the patient's speech rates. A mora is a temporal unit that divides words into almost isochronous segments. We assessed the patient's speech rate on reading The North Wind and The Sun about as fast as possible or at a normal speech speed.
Fig. 2-B shows the progression of his alternating repetitive movements.
Fig. 2-C shows the progression of his oral DDK. In oral DDK, repetitions of a single mora as fast as possible within a fixed period are measured.
These progressions improved by following the pathway of SLP rehabilitation.

fracture.[2-4,10,11] In our case, the O-C2 angle was made approximately 5 degrees wider than the preoperative O-C2 angle; hence, it is possible that his pharyngeal palsy and airway obstruction was partially caused by edema around the pharynx due to either intubation or turning to the prone position.

Lower cranial nerves exit the medulla oblongata at the posterolateral sulcus; moreover, the ninth to eleventh cranial nerves exit the posterior fossa through the jugular foramen. The twelfth cranial nerve runs through the hypoglossal canals. The lower cranial nerves pass between a transverse process of the atlas and a styloid process of the cranial bone.[12,13] Some anatomical reports stated that the gap between a transverse and a styloid process is only 8 to 10 mm. After the fracture, the nerves can be compressed in the gap, causing lower cranial nerve palsies involving the ninth, tenth, and twelfth nerves,[15,16] a mechanism reported by Hsu and Hee.[14,15]

The cranial nerve palsies in our case started to improve first in the ninth and tenth nerves and remained in the twelfth until the end. Since the twelfth cranial nerve is in the gap between a transverse process of the atlas and the styloid process of the cranial bone, subtle positional differences may have altered the severity and prognosis of the lower cranial nerve palsies (Fig. 3).

About the impact of cranial nerve palsies in our case

In our case, severe dysphagia was observed, which required a tracheostomy and intubation using a single-lumen cuffed tracheostomy tube. Pharyngeal sensation is conducted through a pharyngeal branch of the glossopharyngeal nerve and the internal laryngeal nerve of the superior laryngeal nerve. Pharyngeal movement, including swallowing, is controlled by a pharyngeal branch of the vagus nerve.[16] Paresthesia of the pharynx causes impairments of the pharyngeal reflex and swallowing motor system due to malfunction of the central pattern generator in the medulla oblongata.[16,17] In our case, dysphagia improved rapidly following improvement of the paresthesia of the pharynx, pharyngeal reflex, and cough reflex; hence, the palsies in the ninth and tenth cranial nerves improved quicker. Thus, as the sensation and the central pattern generator of

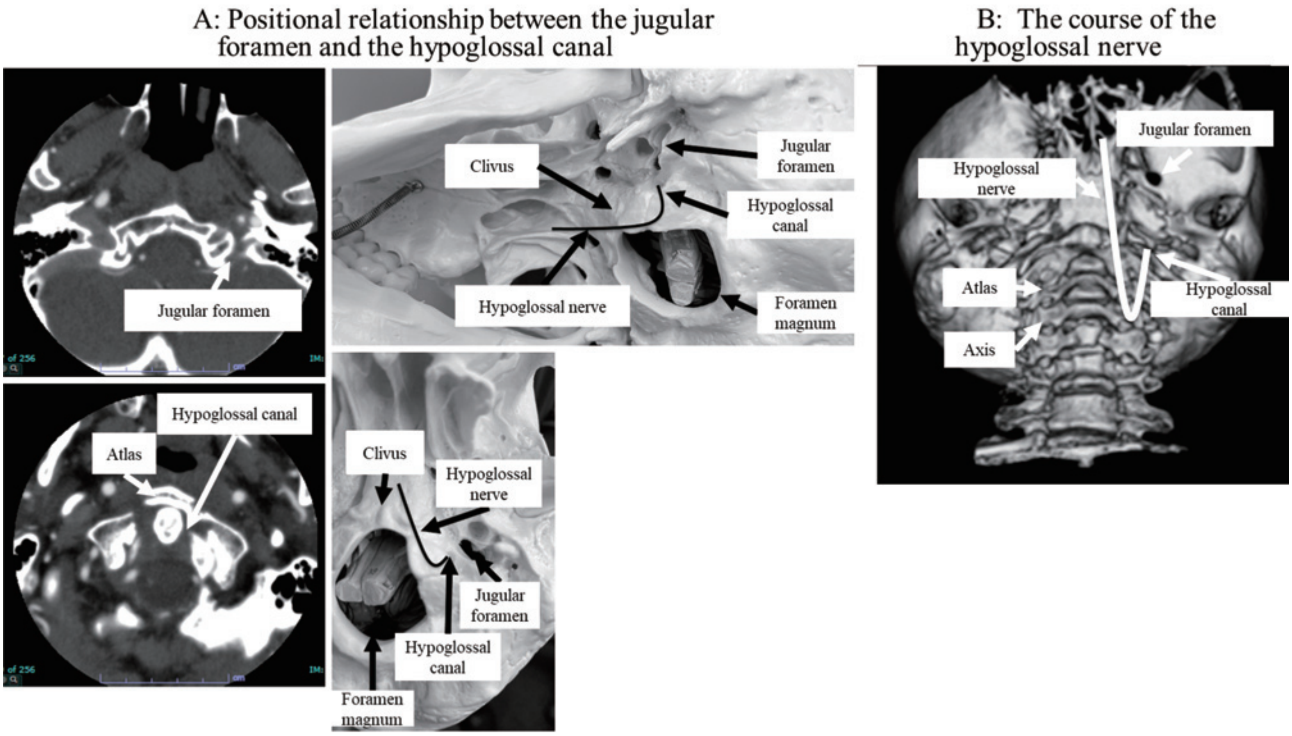

Fig. 3
Fig. 3-B shows the positional relationship of the skull base, the atlas, and the hypoglossal nerve. A Jefferson fracture may be the cause of hypoglossal nerve palsy.

the swallowing motor system improved, dysphagia also improved.

In our case, the palsy in the twelfth cranial nerve persisted and the patient could not speak as fast as before the onset, considerably affecting his quality of life. Dysarthria adversely affects psychosocial functioning and social engagement.[18,19] Thus, patients with mild dysarthria can be as seriously affected as patients with severe dysarthria, depending on their premorbid social status and speech participation. In our case, the complaints about speech did not disappear despite objective improvement in speech clarity.

Three studies on Jefferson fractures have reported that lower cranial nerve palsy due to Jefferson fractures is likely to be overlooked because the clinical symptoms are mild in many cases.[2-4] Studies of long-term dysphagia following Jefferson fracture reported difficulty in treatment,[3] as well as the importance of thorough neurological assessments and provision of rehabilitation.[2,3] Both studies by Connolly et al and Dettling et al reported that Jefferson fractures comprise less than 1% of all spinal cord injuries.[2,4] However, considering that there are cases with poor prognoses and with minor clinical symptoms but possible quality-of-life limitations, it is necessary to expedite rehabilitation intervention.

Informed Consent

The authors' report obtained consent from all the participants.

Conflicts of Interest Disclosure

The authors have no financial conflicts of interest to disclose concerning the study.

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