The Clinical Applicability of Transoral Transpharyngeal Approach to the Craniovertebral Junction Lesions

Tae Goo Cho, M.D., Kwan Park, M.D., Yang-Sun Cho, M.D.,
Chung-Hwan Baek, M.D., Do Hyun Nam, M.D., Jong Soo Kim, M.D.,
Seung-Chyul Hong, M.D., Hyung Jin Shin, M.D.,
Whan Eoh, M.D., Jong Hyun Kim, M.D.

Department of Neurosurgery, Samsung Medical Center Sungkyunkwan University School of Medicine, Seoul, Korea

= Abstract =

두개경추이행부의병소에대한경구적접근법의유용성

Objective: Although transoral transpharyngeal approach is a very useful method for the lesions of craniovertebral junction, it is not frequently used because of anatomical unfamiliarity, risk of cerebrospinal fluid (CSF) leakage, and resultant postoperative meningitis. To evaluate the usefulness of transoral transpharyngeal approach for various lesions of craniovertebral junction, clinical characteristics and the results of this approach are investigated.

Methods: Transoral transpharyngeal approaches were performed in eight cases between 1996 and 1999. Among them, there were three basilar invaginations due to congenital anomalies, two odontoid type I fractures, two atlantoaxial dislocations, and one pseudotumor. Surgical methods included five cases of anterior decompression and posterior fusion, two anterior approaches for decompression and one transoral approach for biopsy.

Results: This procedure allowed immediate clinical improvement in all cases. In seven patients with preoperative motor deficit showed a progressive neurological improvement. The follow-up plain x-rays demonstrated successful bony fusion in all patients. Only one patient suffered from postoperative wound dehiscence, but he completely recovered after wound revision. There was no complication of postoperative CSF leakages.

Conclusions: Transoral transpharyngeal approach for the ventral lesions of craniovertebral junction, can be used as a relatively simple and effective method.

KEY WORDS: Transoral transpharyngeal approach - Craniovertebral junction - Atlantoaxial dislocation - Basilar invagination - Odontoid type I fracture.

Introduction

Ventral compression of the brain stem and rostral spinal cord can be caused by a variety of pathological processes. If the offending pathology is at the level of the inferior clivus, at the cervicomedullary junction, or ventral to the spinal cord at the first three cervical vertebrae, the transoral approach represents an efficacious, direct method for surgical decompression. The most common use of this approach has been for removal of the odontoid process in chronic dens dislocation, basilar invagination due to rheumatoid disease, or congenital malformations at the skull base. The first case using this approach was reported in 1950s by Southwick and Robinson and Mosberg and Lippman. But it took many years for this approach...
regarded as a standard procedure. There were two basic reasons for this: the inherent technical difficulty and the small number of suitable candidates for the operation.

Recent refinements in surgical techniques and intraoperative monitoring have facilitated these procedures and low morbidity and mortality rates can be achieved. The transoral transpharyngeal approach has proved to be a reliable and technically sound method for gaining anterior extradural exposure to the craniovertebral junction (CVJ). In this article, we describe our experience with eight patients who underwent the transoral-transpharyngeal approach to the CVJ lesion.

Clinical Material and Methods

1. Patient population
Eight patients underwent the transoral transpharyngeal approach for ventral extradural brain-stem or rostral cord compression at our hospital. Indications for surgery included progressive neurologic dysfunction caused by congenital or acquired benign ventral pathology at the CVJ. A neurosurgical-otolaryngological team approach was used in each case. The hospital records, outpatient physician records, and radiographic studies of all eight patients were reviewed. Each case was characterized by age, sex, type of pathology, neurological findings, treatment administered, and outcome.

2. Surgical Technique
Each patient was operated under the cooperation with otolaryngologist. After intubation with a flexible reinforced oral endotracheal tube, the patient is positioned in the supine position on the operating room table. Tracheostomy is done in selected cases of preexistent cranial nerve symptoms. Patient's head is secured in a Mayfield fixation device with the head and neck slightly extended. A self-retaining McGarver three-ring retractor is inserted, which spreads the upper and lower jaw widely apart and displaces the tongue and endotracheal tube caudally. Two small redrubber catheters are inserted through the patient's nostrils into the oropharynx and are sutured into the nasopharynx by placing traction on two rubber catheters and tying them to the McGarver retraction apparatus. This combination of retraction affords a wide operative exposure of the posterior pharyngeal wall.

Inspection and palpation of the oral cavity identifies the anterior arch of C1 and body of C2, defining the operative anatomy. A longitudinal midline incision is made in the posterior pharyngeal mucosa. For odontoid pathology, the incision is made directly over the tubercle of the atlas and extended approximately 3.0 cm inferiorly. The anterior ligaments are coagulated and dissected free of the inferior clivus, anterior arch of C1, and anterior bodies of C2, on the basis of the exposure needed. A small peristeal elevator is used to dissect these tissues laterally off the anterior surface of the vertebrae. Under the micro-scope guide a high-speed drill with a small cutting burr or diamond burr is used to perform the bone dissection to remove as much of the arch of the atlas as necessary followed by the odontoid process.

The anterior arch of C1 is resected to expose the base of the odontoid process. Osseous dissection is performed with small cutting burrs and diamond burrs. The soft-tissue structures are detached with curettes and microsurgical tools. After removing the anterior arch of C1 the lateral margins of the odontoid process are defined. The odontoid is removed by transecting it across its base and pulling the center and apex of the dens caudally and ventrally away from the cervicomedullary junction. The base of dens is partially transected with a cutting burr; the osteotomy is completed by removing the posterior cortex of the dens with a 1-mm Kerrison rongeur or with a diamond burr. The dens is grasped with a toothed odontoid rongeur and pulled ventrally and caudally to decompress the neural structures before the ligamentous attachments are cut. The alar and apical ligaments are detached sharply with curved curettes or specialized scissors. The odontoid fragment is then completely removed.

Soft tissue pathology often must be resected to obtain adequate decompression. The transverse ligament and tectorial membrane may need to be removed to visualize the dura and normal pulsation of the thecal sac.

Once the brain stem and spinal cord have been decompressed adequately the wound is irrigated with antibiotic solution, and hemostasis is achieved. Somatosensory cortical evoked responses and brainstem auditory evoked potentials were recorded throughout each of these procedures.

3. Postoperative care
Observation of neurologic function and the airway overnight in the intensive care unit is mandatory. The endotracheal tube is maintained until the patient's tongue swelling subsides. Moderate tongue swelling can be expected after surgery, but it usually subsides within the first 24 to 36 hours.
hours. Head immobilization is achieved with halovest or cervical philadelphia brace. Staged posterior stabilization is planned accordingly. Posterior stabilization procedure can be done immediately after completion of the anterior approach if the postoperative instability is identified.

**Results**

Eight patients underwent a transoral transpharyngeal approach to the CVJ for ventral pathology. Patient age ranged from 14 to 59. Five patients were women and three were men.

The presenting symptoms and neurological signs are outlined in Table 1. All patients complained of neck pain, weakness of the arms and/or legs. On examination, all patients had a decreased range of head and neck motion. Motor weakness was common finding in both upper and lower extremities. All patients were treated via the transoral approach for resection of their extradural compressive pathology or biopsy. Of these eight patients, three had basilar invagination due to congenital anomalies with brain-stem compression, two had chronic traumatic odontoid fracture type I with persistent posterior dens dislocation, two had traumatic atlanto-axial dislocation and one had pseudotumor on the high cervical area (Table 2).

Five patients were operated on while in a halovest immo-
Tracheostomy was not routinely performed. Three patients requiring tracheostomy were those who had preoperative brain stem symptoms and anticipated difficult postoperative courses. Oral or nasotracheal intubation was performed in five patients. To gain adequate surgical exposure, in four patients the soft palate was split from the midline extending from the junction with the hard palate to the base of the uvula, and then the uvula was laterally resected deviating from the midline to one side in four patients.

Postoperative neurological status and stability have been assessed periodically by clinical and radiological follow-up. Eight patients have been followed for 6 months to 35 months, with a mean of 18 months. Good results (cure or significant improvement) were achieved in seven patients, and stabilization of the neurological symptoms in one. One patient already underwent posterior decompression and fusion procedures and the other patient underwent posterior fusion procedures at other hospitals due to atlanto-axial dislocation. But their symptoms of neck pain and motor weakness aggravated postoperatively, and referred to our hospital.

There were three patients with basilar invagination due to congenital anomalies. Two patient demonstrated assimilation of atlas. All of these three patients underwent anterior decompressive odontoidectomy and the posterior fusion procedures. All patients showed neurological improvement immediately after the surgery. The first patient was a 46-year-old woman presented with quadri- paresis for eight years with no previous history of trauma. The patient had dysarthria, swallowing difficulty, neck pain and occipital headache. She underwent a posterior decompression about three years ago for the cervical myelopathy at the other hospital, but her symptom aggravated. The MR image of the cervical spine demonstrated basilar invagination syringomyelia and Chiari type I and assimilation of atlas and block vertebra of C2-3 (Fig. 1). At first, we performed posterior approach and bone fusion with autologous rib graft and wire fixation due to the previous posterior decompressive procedures, then halovest applied (Fig. 2).

One week later, transoral transpharyngeal odontoidectomy was performed for the decompression of brain stem. Halovest was removed after confirming the posterior bony fusion after six months of operation. At three years follow-up her weakness, dysarthria, swallowing difficulty and atactic gait were significantly improved.

Two patients had nonunion of old odontoid fracture type I and presented with quadripareisis and left side hemiparesis. One patient underwent transoral transpharyngeal odontoidectomy and posterior fusion procedure, but the other patient had already undergone posterior decompression and fusion and so we performed only anterior decompressive odontoidectomy. The first patient was a 39-year-old woman presented with quadripareisis. She had a fall down injury about 30 years ago. Since about 2 years before hospitalization, she had exhibited progressive spastic quadripareisis with 4/5 strength in both arms and legs on admission. The patient's speech was dysarthric. Preoperative MR image demonstrated an old odontoid fracture type I and severe compression of spinal cord by displaced odontoid process (Fig. 3a & b). Initially, we applied halovest preoperatively, and craniovertebral junction was successfully decompressed with the transoral transpharyngeal odontoidectomy, and the hypertrophied transverse ligament also removed. Posterior fusion procedures also performed using the autologous rib graft (Fig. 4). Halovest was removed after 6
months of stabilization. The patient’s weakness greatly improved immediately after the transoral transpharyngeal odontoidectomy.

Two patients had traumatic atlanto-axial dislocation with brain stem compression symptoms of hemiparesis and quadripareisis. These patients treated via the transoral resection of extradural ventral compressive pathology and posterior fusion. One patient was a 14-year-old boy with progressive paraparesis. He had a fall down injury when he was 1-year-old. Preoperative MRI demonstrated atlantoaxial dislocation and severely compressed cord (Fig. 5). We performed anterior decompressive odontoidectomy first and then posterior fusion procedure with rod and autologous on-lay rib graft (Fig. 6).

Of eight patients, three had postoperative complications. The first patient, a 59-year-old woman with a chronic type I odontoid fracture developed a postoperative wound dehiscence with infection. She underwent reoperation for debridement and Z-plasty. There was no CSF leak, she healed well after the wound revision and four weeks of antibiotic therapy. At follow-up examination 34 months postoperatively, she had made an excellent recovery.

The second patient, a 39-year-old woman with a chronic type I odontoid fracture developed a postoperative oral candidiasis. There was no CSF leak, and white patch was covering the nasopharynx and incision wound. She later required a posterior wiring and fusion procedure. She recovered well from the oral candidiasis with nystatin gargling and oral antifungal agent for four weeks. At follow-up examination 32 months postoperatively, she made a good recovery.

The one mortality occurred in a 63-year-old diabetic patient in whom a large pseudotumor developed from the skull base to the C1-C2-C3 area. The transoral transpharyngeal biopsy revealed a chronic inflammatory reaction...
with granulation tissue. He underwent a radiation therapy, but his neurologic condition deteriorated. The follow up MRI showed spreading of pseudotumor. A halovest was administered for the stabilization of CVJ. No fusion procedures indicated due to his bad clinical condition of uncontrollable diabetes mellitus and poor nutrition state. At three months follow up, he was admitted for readjustment of halovest and his neurological condition aggravated and blood sugar level was uncontrollable. He died of medical complications.

Discussion

The transoral operative approach may be regarded as a standard procedure for the treatment of selected CVJ malformations and other ventrally situated extradural lesions\(^7\)\(^8\)\(^9\)\(^10\), including basilar invagination due to congenital anomaly or rheumatoid arthritis, odontoid dislocations, posterior pharyngeal abscesses, tuberculomas, congenital skull base neoplasms, metastatic neoplasms, osteomas, chordomas, sarcomas, schwannomas, aneurysms, arterio-venous malformations, and epidermoid tumors\(^11\)\(^12\)\(^13\)\(^14\)\(^15\)\(^16\)\(^17\)\(^18\)\(^19\).

Recent refinements in microsurgical skills and advances in retraction techniques, operative magnification, intraoperative radiography, dural closure techniques, and neuroelectrophysiological monitoring have dramatically improved patient outcome following transoral operative procedures\(^9\)\(^14\)\(^15\).

The indication for this approach is often complicated. The location of pathology and mechanism of brain-stem or spinal cord compression are the important factors that determine surgical approaches\(^9\)\(^14\)\(^15\). Generally, the ventral CVJ pathology should be approached anteriorly, dorsal pathology is best treated from a posterior approach\(^9\). In this series, two patients with ventral pathologies underwent posterior decompression and fusion procedures at other hospitals with poor outcome. A number of patients, especially those with basilar invagination due to congenital skull base C1-2 anomalies, will require a combination of surgical procedures to remove offending ventral pathology and to provide posterior stabilization. Dynamic flexion and extension studies will indicate the presence or absence of reducible ventral CVJ compression\(^9\). If the ventral brain-stem compression is reduced by the head and neck extension, the patient may be a candidate for a posterior fusion.
procedure only. All patients are routinely reevaluated postoperatively by x-ray studies after the transoral procedure. Dynamic flexion and extension radiographs can identify delayed instability after the transoral decompression. Dickman has reported that the transoral resection of dens, anterior arch of C-1, and the lower clivus does not fully destabilize the spine however the operation may potentiate incipient pathological instability. The primary determinants of instability were the extent of pathological bone destruction, ligamentous weakening, and operative bone removal. He concluded that preexisting patient disease is an important factor in determining if instability will occur following transoral surgery. Ninety percent of patients with rheumatoid arthritis presented with instability or rendered by the transoral procedure, but only 45% of patients with congenital osseous malformations required internal stabilization. Fortunately, patients with CVJ pathology due to rheumatoid arthritis are rare in Korea.

The application of this approach have been limited due to high perioperative morbidity and mortality rates among treated patients. The majority of surgeons have performed these transoral approaches only after tracheostomy, but recently tracheostomy is performed only in cases of which preoperative brain stem symptoms are present or postoperative courses are expected to be difficult. Hard palates is rarely incised to obtain adequate operative procedures, and these adjunctive maneuvers add significantly to postoperative morbidity. The transoral approach has been associated with a high mortality rate resulting from persistent CSF fistulae, meningitis, abscess formation, which occur when the dura matter cannot be closed effectively.

The use of intraoperative lateral radiographs (fluoroscopy) with or without positive-contrast dye is an important surgical adjunct for the transoral-transclival operative procedure. The initial lateral radiograph confirms the location of the anterior arch of atlas and demonstrates the extent of head and neck extension. The depth, width, and rostral and caudal extents of the decompression can be documented at the time of surgery.

The transoral operation is a high risk surgical procedure when treating patients with significant brain stem or spinal cord compression. Any further compromise, even if transient, has the potential to aggravate the patient’s neurological deficits. Intraoperative neurophysiological monitoring with evoked somatosensory and brain stem auditory poten-
tials has been helpful in the operative treatment of six patients in this series. There was no abnormal findings of intrapreoperative neurophysiological monitoring to predict postoperative neurological worsening. But according to Hardley’s report, they demonstrated the predictive value of potential brain stem or spinal cord injury and their correlation between observed intraoperative responses and clinical outcome\(^\text{19}\).

Of the eight patients, we performed posterior fusion and stabilization in five patients. Two patients had already undergone posterior fusion at other hospital, and we performed only anterior decompressive odontoidectomy. The other patient had a debilitating medical problems of pneumonia, urinary tract infection and poorly controlled diabetes mellitus interfering posterior fusion procedures. We maintained the halo vest to help devastating instability, but the patient died of medical complications.

Transoral surgery is contraindicated if an active nasopharyngeal infection is present or if any abnormal vascular structures interfering the surgical field (i.e., anomaly of the vertebral or basilar arteries). Basically, it is inappropriate for intradural pathology due to the risks of meningitis and CSF leakage\(^\text{17,19}\). But intradural lesions such as tumor or aneurysm were also removed by this approach\(^\text{8,13,29}\). These complications reflect the inability to obtain a watertight dural closure transorally.

The neurological outcome of patients treated with transoral odontoidectomy is directly related to the severity of their preoperative neurological deficits. Ambulatory patients demonstrate the most neurological recovery after surgery. Early detection and treatment of pathology can facilitate recovery\(^\text{9}\). But in this series, two patient had the long history of brain stem compression symptoms of weakness longer than 20 years. Postoperatively, their weakness also much improved with other symptoms such as neck pain and swallowing difficulties. These findings suggest that the long duration of symptoms does not always predict poor outcome, and aggressive treatment would be helpful in chronic cases also.

**Conclusion**

From our experience, transoral transpharyngeal approach would be an effective surgical method for the direct decompression of ventral midline extradural compressive pathology of CVJ. This procedure is facilitated with wide retraction of the mouth and oropharyngeal soft-tissue boundaries. Tracheostomy is rarely necessary, and morbidity is acceptably low with this approach.

- Dickman CA, Spetzler RF, Sonntag VKH\[ Transoral approach to the craniovertebral junction, in Dickmann CA, Spetzler RF, Sonntag VKH\[ Surgery of the craniovertebral junction. New York: Thieme, 1998, pp355-369\]
- Dickman CA, Crawford NR, Bramley AGU, Sonntag VKH\[ In vitro cervical spine biomechanical testing. BNI Quarterly 9:17-26, 1993\]
- Drake CG\[ Treatment of aneurysms of the posterior cranial fossa. Prog Neurol Surg 9:122-194, 1978\]
15) Hadley MN, Spetzler RF, Sonntag VK. The transoral approach to the superior cervical spine. J Neurosurg 71(1) 16-23, 1989
30) Yang SY, Gao YZ. Clinical results of the transoral operation for lesions of the craniovertebral junction. Surg Neurol 51(1) 16-20, 1999
두개 경추 이행부의 병소에 대한 경구적 접근법의 유용성
조태구·박관·남도현·김종수·홍승철·신형진·이환·김종현

목적

본 연구에서는 두개 경추 이행부에 발생한 병소에 대해 경구적 접근법을 적용한 임상적 결과를 분석하여

방법

1996년 9월부터 1999년 4월까지의 8년 7개월 동안의 30여 건의 병소에 대해 본 접근법을 사용하였으며, 22여 건은

결과

결론

중심 단어