One-stage surgical management for tuberculosis of the upper cervical spine by posterior debridement, short-segment fusion, and posterior instrumentation in children

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Abstract

Purpose To evaluate the clinical study efficacy and feasibility of 11 children with tuberculosis of the upper cervical spine treated by one-stage posterior debridement, short-segment fusion, and posterior instrumentation.

Methods Eleven children who suffered from tuberculosis of the upper cervical spine were admitted to our hospital between June 2005 and December 2010. All of them were treated by one-stage posterior debridement, short-segment fusion, and posterior instrumentation. Then, the clinical efficacy was evaluated using statistical analysis based on the materials about the visual analogue scale (VAS) scores of pain, JOA scores of nerve function and erythrocyte sedimentation rate (ESR), which were collected at certain time.

Results The average follow-up period was 28.1 ± 10.5 months (13–42 months). In the 11 cases, no postoperative complications related to instrumentation occurred and neurologic function was improved in various degrees. The average pretreatment ESR was 58.4 ± 4.9 mm/h (53–69 mm/h), which got normal (8.9 ± 6.5 mm/h) within 3 months in all patients. The average preoperative VAS was 7.4 ± 2.2 , which decreased to 1.6 ± 1.8 postoperatively. Mean preoperative JOA was 11.2 ± 3.8 , and the JOA at the last visit was 16.3 ± 1.0 . All patients got bony fusion within 3–8 months after surgery.

Conclusions One-stage posterior debridement, short-segment fusion, and posterior instrumentation can be an effective treatment method for the treatment of tuberculosis of the upper cervical spine in children.

Keywords Tuberculosis · Upper cervical spine · Children · Posterior instrumentation · Short-segment fusion

Introduction

There is an increasing incidence of tuberculosis in developing countries. Tuberculosis of the upper cervical spine is rare. Children who are predisposed to tuberculosis have suffered an increased incidence of bone and joint tuberculosis over the past decade. Any infection at this site must be diagnosed early and treated rapidly. Death is usually due to atlantoaxial dislocation causing compression of the cord [1]. It is too danger that tuberculosis of the upper cervical spine can cause the upper cervical instability, spinal cord injury, and the nerve root and vertebral artery invasion. The treatment of tuberculosis of the upper cervical spine in children is described as atypical and case reports are published as rarities in the mainstream academic journals. To our knowledge, surgical treatment of this disease has rarely been reported. The purpose of the study is to evaluate the effectiveness and safety of single-stage posterior debridement, short-segment fusion, and posterior instrumentation for children with tuberculosis of the upper cervical spine.

Materials and methods

Basic information

From June 2005 to December 2010, 67 patients with the diagnosis of tuberculosis of the upper cervical spine underwent surgery at our spinal center, including 11 children who suffered from tuberculosis of the upper cervical

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spine: seven of them were males, and four were females, aged from 6 to 14 years (with an average age of 11.4 ± 2.5 years). The diagnosis of tuberculosis of the upper cervical spine guided by non-specific laboratory findings such as anemia, hypoproteinemia, and elevation of erythrocyte sedimentation rate (ESR) and by imageology findings including spinal X-ray films, computed tomography, and magnetic resonance imaging. All patients were presented with constitutional symptoms including weakness, malaise, night sweats, neck pain and stiffness, local tenderness and spasm of the posterior muscles of the neck, and lower fever with weight loss and variable degree of local deformity angle. Although retropharyngeal abscesses of different size were present in all patients, symptomatic dysphagia occurred in none. Of 11, nine patients were complicated with incomplete paraplegia. The classification of the American Spinal Injury Association (ASIA) [2] (Table 1) was used to assess the neurological compromise function, 1 case in grade B, 3 cases in C, and 5 cases in D. The ESR of patients upon admission ranged from 53 to 69 mm/h, with an average of 58.4 ± 4.9 mm/h.

Preoperative procedure

Two weeks prior to the operation, the patients were administered antituberculosis drug with isoniazid (5–10 mg/kg/day with no more than 300 mg/day), rifampicin (5–10 mg/kg/day with no more than 300 mg/day), and ethambutol (15 mg/kg/day with no more than 500 mg/day). Preoperative halo traction plays an important role in partial correction of atlantoaxial subluxation. Seven children required preoperative halo traction. When the patients resumed normal appetite without low fever, anemia and hypoproteinemia were rectified completely, and ESR had significant decrease, surgery was carried out.

Operative procedure

Surgery was performed under general endotracheal anesthesia. The patients were placed in a prone position, maintaining halo traction of 3 kg to stabilize the spinal column and leadership position. Median longitudinal incision was used. The nuchal ligament was incised 1 cm below the occipital protuberance until the C4 spinous process. Posterior arch of the atlas revealed no more than 1.5–2 cm, C2–4 were exposed to the outer edge of the lateral mass. We did the debridement using preoperative design by cutting off the posterior arch of atlas when the lesion was presented in the posterior arch of atlas, or corresponding parts were removed when the lesion was in C1 and C2 lateral mass. We had to make sure the

Table 1 Clinical data on all patients

Patient no.	Age	Follow-up (months)	Sex	ASIA		VAS		ESR		JOA	
				Pre	LV	Pre	Post 1 week	Post 3 months	Pre	Post 1 week	Post 3 months
1	14	13	M	D	E	7.5	0	0	58	12	16
2	12	36	M	C	E	2.5	0	0	53	9	16
3	13	16	F	C	E	10	4.5	1	60	8	17
4	12	20	M	E	E	6	1	0	55	15	17
5	6	42	M	D	E	8	2	0	55	13	17
6	9	38	M	D	D	9	5	2	65	13	17
7	14	25	F	B	D	8.5	1.5	0	69	4	14
8	9	17	M	E	E	7.5	0	0	56	17	17
9	11	28	M	D	E	5.5	0	0	60	14	17
10	13	34	F	C	E	10	2	0	57	7	16
11	12	40	F	D	D	7	2	0	54	11	15
Mean values	11.4 ± 2.5	28.1 ± 10.5				7.4 ± 2.2	1.6 ± 1.8	0.27 ± 0.65	58.4 ± 4.9	11.2 ± 3.8	16.3 ± 1.0

M male, F female, Pre preoperative, Post postoperative

safety of vertebral artery and vein, C1 and C2 nerve root. The material debrided was sent for culturing and histopathologic examination. Besides, short-segment fusion and posterior instrumentation were carried out. We performed the C1–2 posterior transarticular UCSS screw fixation combined with C1–2 posterior Gallie [3–6] titanium cable fixation when the axial and lateral masses of atlas were complete. However, we performed pedicle screws in bilateral of atlas and the non-lesion side of axis when one side of axis destruction occurs, at the same time, the bilateral lateral mass screw or pedicle screws were placed in C3. Although the above steps were completed, we made the laminectomy rear become rough by rongeur and fusion by allogeneic bone. Treatment with 1.0 g streptomycin and 0.2 g isoniazid was locally administered.

Postoperative procedure

The drain was usually removed when drainage flow was <50 ml/24 h. After surgery, patients were allowed to ambulate after remaining supine for 5–7 days (mean 6 days) postoperatively. A plastic orthosis was given to each patient, which was continued at least 6 months in average, postoperatively. To those cases using extra isoniazid preoperatively, the same dose of isoniazid was given in addition for 3 days postoperatively by intravenous drip, combined medication of oral administration of rifampin 450 mg and pyrazinamide 1,500 mg. Three days later, patients used combined medication by oral administration of isoniazid 300 mg, rifampin 450 mg, and pyrazinamide 1,500 mg, and then such chemotherapy was continued for more than 18 months postoperatively, and reviewed liver function on a regular basis.

Follow-up index and statistical analysis

For all cases, the average follow-up period was 28.1 ± 10.5 months (13–42 months), the following indexes were recorded pre-, postoperatively, and during the follow-up: (1) visual analogue scale (VAS), (2) neurological status, and (3) ESR. Using SPSS 19.0 software, JOA (Table 2), VAS, and ESR were statistically analyzed by paired *t* test pre-, postoperatively, and during the follow-up. Discrepancy of the normal distribution was analyzed by a rank-sum test with a significance level of 0.05.

Results

The mean duration of surgery was 172 min and the mean blood loss was 1,200 ml. Wounds were healed without

Table 2 Japanese Orthopaedic Association Scores (cervical vertebra)

Section	Contents	Score
I	Motor function of the upper extremity	
	Unable to eat with either chopsticks or a spoon	0
	Able to eat with a spoon, but not with chopsticks	1
	Able to eat with chopsticks, but inadequately	2
	Able to eat with chopsticks, but awkwardly	3
	Normal	4
II	Motor function of the lower extremity	
	Unable to walk	0
	Needs a cane or other walking aid on flat ground	1
	Needs walking aid only on stairs	2
	Able to walk unaided, but slowly	3
	Normal	4
III	Sensory function	
	a. Upper extremity	
	Apparent sensory disturbance	0
	Minimal sensory disturbance	1
	Normal	2
	b. Lower extremity	
	Apparent sensory disturbance	0
	Minimal sensory disturbance	1
	Normal	2
	c. Trunk	
	Apparent sensory disturbance	0
	Minimal sensory disturbance	1
	Normal	2
IV	Bladder function	
	Urinary retention or incontinence	0
	Severe dysuria (sense of retention)	1
	Slight dysuria (pollakiuria, retardation)	2
	Normal	3

The score in a normal subject is the total of the best scores: I–IV

chronic infection or sinus formation. No complications related to instrumentation occurred. The average pretreatment ESR was 58.4 ± 4.9 mm/h (53–69 mm/h), which got normal (8.9 ± 6.5 mm/h) within 3 months in all patients (Table 1). The average preoperative VAS was 7.4 ± 2.2 , which decreased to 1.6 ± 1.8 postoperatively. Mean preoperative JOA was 11.2 ± 3.8 , and the JOA at the last visit was 16.3 ± 1.0 . At the last follow-up visit, neurologic status of the nine patients with preoperative neurologic deficit was 5 with grade D, three recovered to normal and two still in grade D; one with grade B recovered to grade D; three with grade C, all of them to grade E. CT and X-ray were used to assess the fusion and the formation of a bone bridge (Figs. 1, 2). All patients achieved bone fusion within 3–8 months after surgery.

Case presentation

Case one (Fig. 1)

A 14-year-old female, axis destruction and formation of epidural cold abscess, posterior debridement, short-segment fusion, and posterior instrumentation in C1–C3, preoperative ASIA Grade was B grade, and at the final follow-up was D grade. Preoperative radiography showed destructive segments located at C2 and preoperative CT and MRI showed C2 vertebral body was almost vanished and abscess was localized (Fig. 1a–d). Postoperative roentgenographs and CT showed atlas with bilateral pedicle screws, axis with left pedicle screw and C3 with bilateral lateral mass screw (Fig. 1e–h). Twenty-five month's postoperative roentgenographs showed internal fixation with good and bone fusion (Fig. 1i).

Case two (Fig. 2)

A 12-year-old male, axis destruction and formation of epidural cold abscess, posterior debridement, short-segment fusion, and posterior instrumentation in C1–C2, preoperative ASIA Grade was C grade, and at the final follow-up was E grade. Preoperative CT showed C2 vertebral body was almost vanished and abscess was localized

(Fig. 2a, b). Thirty-six month's postoperative CT showed that the C1–2 posterior transarticular UCSS screw fixation combined with C1–2 posterior Gallie was performed, internal fixation with good and bone fusion (Fig. 2c, d).

Discussion

Tuberculosis of the upper cervical region is rare and accounts for just 10 % of all cases of spinal tuberculosis [7]. The atlantoaxial junction is the least common site for presentation of spinal tuberculosis, accounting for just 1 % of all cases of spinal tuberculosis [8, 9]. The spinal cord in this region in patients with tuberculosis is threatened by atlantoaxial subluxation, compression by an abscess, or by direct tuberculous invasion. Dhammi [10] reported one patient had hemiplegia while two had monoplegia out of 32 patients who suffered from tuberculosis of the craniovertebral region treated at his institution. Therefore, to be decompressed, a debridement is necessary. The disease has an insidious onset, presenting usually with neck pain, and is often misdiagnosed in the early stages as cervical spondylitis. Gross destruction and neurological deficit are evident only in the later stages.

Surgical treatment was performed only on patients with the loss of the anterior column severe or progressive

Fig. 1 A 14-year-old female, axis destruction and formation of epidural cold abscess, posterior debridement, short-segment fusion, and posterior instrumentation in C1–C3, preoperative ASIA Grade was B grade, and at the final follow-up was D grade. Preoperative radiography showed destructive segments located at C2 and preoperative CT and

MRI showed C2 vertebral body was almost vanished and abscess was localized (a–d). Postoperative roentgenographs and CT showed atlas with bilateral pedicle screws, axis with left pedicle screw and C3 with bilateral lateral mass screw (e–h). Twenty-five month's postoperative roentgenographs showed internal fixation with good and bone fusion (i)

Fig. 2 A 12-year-old male, axis destruction and formation of epidural cold abscess, posterior debridement, short-segment fusion, and posterior instrumentation in C1–C2, preoperative ASIA Grade was C grade, and at the final follow-up was E grade. Preoperative CT showed C2 vertebral body was almost vanished and abscess was

localized (**a, b**). Thirty-six month's postoperative CT showed that the C1–2 posterior transarticular UCSS screw fixation combined with C1–2 posterior Gallie was performed, internal fixation with good and bone fusion (**c, d**)

neurologic dysfunction, spinal instability, severe spinal deformity, and paravertebral abscesses. Besides, this method should be adopted for retropharyngeal abscesses of little size, atlantoaxial destruction but lateral mass complete, and unnecessary to get debridement in each lesion according to the specific circumstances of the case. In advanced disease that extensive destruction has occurred, the stability of the atlantoaxial joint is lost. In such cases, in those with neurological deficit or impending compromise of the cord, surgical stabilization with fusion posteriorly is required, with transoral decompression.

Various surgical techniques have been used to treat spinal tuberculosis, but few literatures on treating tuberculosis of the upper cervical spine in children by posterior

procedure have been reported. Although it is agreed that via a transcervical retropharyngeal approach for atlantoaxial tuberculosis allows anterior neural decompression and stabilization of the spine by bone grafting, several severe complications such as mixed infection and postoperative nursing tasks have been described in the literature [11]. For children with spinal tuberculosis, anterior radical debridement destroys the anterior growth and limits the capacity for spinal remodeling, which leads to progressive kyphosis [12]. Nowadays, as posterior instrumentation has become popular, a technique for tuberculous spondylitis and more effective regimens of antituberculous chemotherapy have become available [13]. Posterior instrumentation can effectively prevent the excessive growth of the

posterior column in children [14, 15]. Posterior instrumentation surgery was not a risk in spinal tuberculosis infection. It has been proven that tubercle bacillus has no adhesiveness to autogenous bone and instruments, therefore it is safe to graft bone and use instrumentation in an infection focus [16]. Mehta and Bhojraj [17] reported good results after posterior transpedicular debridement and posterior instrumentation without anterior debridement in the patients at a high risk for transthoracic surgery because of their poor medical condition.

In our series, we carried out posterior debridement, short-segment fusion, and posterior instrumentation in the treatment of tuberculosis of the upper cervical spine in children. All patients obtained satisfactory functional restoration and recovery from tuberculosis of the upper cervical spine through debridement, decompression and stabilization of the spinal cord. Eight patients with functional nerve impairment recovered to ASIA E. Posterior short segments instrumentation which is a rigid stabilization system can provide better movement of the cervical spine and is beneficial to the stress dispersion which effectively prevents implants failure. In addition, it can achieve relief of pain due to atlantoaxial subluxation. Posterior resection of atlantoaxial lateral mass, vertebral lamina, spinous process and the posterior arch of the atlas of the lesion are relatively easy, but it has high risk to do the resection of vertebral body and anterior arch of atlas and axis lesion. We usually do the resection of atlantoaxial lateral mass or scraping the front focuses by pedicle drilling. Besides, we have to pay attention to avoid impairing the nerve and great vessels when atlantoaxial lateral mass resection is performed. Wright [18] reported that the incidence of vertebral artery injury is 2.4 %. Xu [19] reported the overall percentage of nerve violation was significantly higher than that with the Magerl in 95 %. Bapat [20] suggested defining the pattern of erosion of the articular surfaces of the atlas and the axis contributed to saving patients for rigid segmental fixation, and sparing the occiput improves the fusion rate. The nail placement of Magerl techniques with lateral mass screw fixation in upper lateral C2 facet cannot be too close to the C2 and C3 joints. Atlas pedicle screw for vertebral artery groove should be placed below the posterior tubercle of the arc distance from point 18 to 20 mm, posterior arch rim above 2 mm. Furthermore, placement of axis vertebral pedicle screw is in the middle of lateral mass axis. There were no cases of persistence or recurrence of infection after surgery, and instrumentation provided immediate stability. Furthermore, treatment in time can reverse paralysis and minimize the potential disability. Some children's significant neurological improvement was seen immediately postoperatively followed by a return of the paraplegia due to succeeding cord compression. It is important for children to have early

diagnosis and therapy to prevent tuberculosis of the upper cervical spine.

The four factors below, in our opinion, are the main advantages over other methods. First, these patients were in the poor condition and it was felt that surgery would submit them to a high anesthetic risk, with feasibility for severe postoperative complications. One-stage surgery by posterior debridement, short-segment fusion, and posterior instrumentation reduces the blood loss and anesthesia time. Second, as a result of the simple anatomical in the surgical approach, the complications are few. Third, posterior atlantoaxial lateral mass excision, dural sac, and nerve roots can directly be visualized. Thus, this technique is highly effective for decompression, especially for the patients with preoperative neurologic deficit. Finally, to multilevel fixation, the posterior instrumentation can get firmer fixation and more kyphosis correction than anterior plate system.

Upadhyay [21] and Schulitz [12] suggested that debridement without bone grafting can reduce traumatic and correct the kyphosis deformity in the children with spinal tuberculosis. In our opinion, the children with small vertebrae and narrow space created after debridement should not be given interbody bone graft because poor bone grafting is due to small area of contact between the adjacent normal vertebral bodies and the placement of grafts. In addition, tuberculous lesion may heal in spontaneous fusion. Meanwhile, we performed debridement rather than radical resection, and posterior fusion and instrumentation can provide sufficient fixation strength. However, if the lesion was too large, which may affect stability of posterior instrumentation, we considered bone grafting.

The problem of our study is whether there is benefit for removal of the implants. Because of the plasticity of the immature spine during growth, we may risk further kyphosis if the implants are removed too early. In view of the fact that the usage of pedicle screws is possible without adverse effects in the growing child [22–24], we recommend at present to remove the implants until the end of growth.

Conclusion

There is also dispute about the treatment of tuberculosis of the upper cervical spine in children. One-stage posterior debridement, short-segment fusion, and posterior instrumentation can be effective treatment methods. These methods can effectively relieve pain symptoms, improve neurological function and reconstruct the spinal stability. In addition, short-segment fusion maximum preserved cervical activity function and fewer traumas. So far the clinical

and radiographic results of these patients were good, but all of the patients in our study have significant growth remaining, and there are preliminary results in a small group of patients with relatively short follow-up for some patients. By all means, further study with a large number of patients and longer follow-up will be necessary.

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Conflict of interest None of the author has any potential conflict of interest.

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