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Posterior stabilization of the cervical spine with hooks and screws. A clinical evaluation of 26 patients with traumatic, degenerative or metastatic lesions, using a new implant system

Received: 18 February 2000
Revised: 16 June 2000
Accepted: 27 June 2000
Published online: 4 November 2000
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Abstract We operated on 26 patients with cervical spine disorders (13 with traumatic lesions, 3 with spinal stenosis and myelopathy, 1 with osteomyelitis and 9 with metastasis) with posterior stabilization. A new implant system (Cervi-Fix) based on rods, enabling a choice of either screw or laminar hook fixation in a free combination, was used. The system was evaluated for ease of use, for safety, regarding complications related to the system, and for efficacy, regarding loss of correction and signs of instability. The patients were followed for a mean period of 11 months, with ordinary and flex-

ion/extension radiographs and clinical examination. No complications related to the implant system were observed. Loss of correction was observed in one patient. We found constructs with few vertebral fixation points, especially with screws, easy to handle, whereas multiple-claw constructs were time consuming. This implant system seems to be versatile, safe and efficient, but could be improved by the development of instruments for the insertion of the hooks.

Key words Cervical spine · Posterior fixation

Introduction

Instability of the cervical spine, whether traumatic, degenerative or metastatic, may need internal fixation. Different pathologies require different surgical techniques for stabilizing the cervical and upper thoracic spine.

The treatment of cervical spine disorders has changed from minimal internal fixation to the development of new instrument systems. The use of posterior internal fixation in the cervical spine is expanding [9]. Although several methods are available for posterior stabilization of the occipito-cervical junction and the cervical and upper thoracic spine, few implant systems allow optimal screw insertion combined with sublaminar hooks.

The purpose of this paper was to prospectively evaluate the safety and efficacy of a new implant system, which allows for a combination of screws and sublaminar hooks, in patients with traumatic, metastatic and degenerative diseases of the cervical and upper thoracic spine.

Materials and methods

Between August 1996 and July 1998, the authors operated on 26 consecutive patients with a new implant system (Cervi-Fix) for posterior stabilization of the cervical and upper thoracic spine.

The mean age of the patients was 52 years (range 21–82 years). Indications for surgery were traumatic lesions (13 patients), spinal stenosis with myelopathy (3 patients), osteomyelitis of the spine (1 patient) and metastasis (9 patients).

Two of the 13 patients with traumatic lesions were quadriparetic; two patients were neurologically intact and nine had radiculopathies due to dislocation or facet fracture.

Combined anterior and posterior stabilization was performed in five patients (Table 1, cases 6, 9, 12, 13, 23). Two patients (cases 12, 13) were operated with anterior and posterior stabilisation according to our treatment protocol for ankylosing spondylitis. One patient with tuberculous spondylitis (case 23) was operated on with anterior excision of the infected vertebrae and strut grafting combined with a posterior instrumented stabilization. In two patients (cases 6, 9) with facet joint dislocation, a combined anterior and posterior procedure was performed due to disc herniation and an unsuccessful anterior reposition attempt.

The occipito-cervical junction was stabilized in three patients with metastasis in the upper cervical spine (cases 14, 18, 22), and

Table 1 Twenty-six patients treated by posterior cervical fixation (*Sc* screw, *Ho* hook, *Occ* occiput)

Case	Age	Sex	Disease process	Stabilized levels ^a	Implants	Follow-up (months)
1	35	M	Disloc. C6/7	C6–7	Sc C6,7	28.5
2	80	F	Disloc. C4/5	C4–5	Sc C4,5	24
3	39	F	Disloc. C6/7; facet fract.	C5–7	Sc C5; Ho C7	21
4	26	M	Disloc. C5/6; facet fract.	C5–6	Sc C5; Sc/Ho C6	17
5	21	M	Fract.-lux. C2–6	C3–7	Ho C3–7	15.5
6	30	M	Disloc. C6/7; lamina/facet fract.	C4–7	Sc C4/5; Ho C7; anterior plate C6/7	12.5
7	51	M	Disloc. C5/6	C5–6	Sc C5,6	16
8	23	M	Disloc. C6/7	C5–7	Sc C5; Ho C7	–
9	21	M	Disloc. C5/6; disc herniation	C5–6	Sc C5; Ho C6; anterior plate C5/6	11.5
10	39	F	Disloc. C6/7,	C6–T1	Ho C6; Ho T1	7
11	39	M	Dislo C6/7; lamina/facet fract.	C6–7	Sc C6; Ho C7	8
12	82	M	Fract-disloc. C7/T1	C6–T2	Ho C6, Ho T2; anterior plate C7/T1	0.5
13	60	M	Ankylosing spondylitis; fracture	C7–T1	Ho C4,5, Ho T1,2; anterior plate C7/T1; Halo vest 6 weeks after surgery	10
14	78	M	Esophagus cancer	Occ–C6	Sc occ; Ho C5,6	2
15	54	F	Plasmocytoma	C7–T4	Ho C7 (claw); Ho/Sc T4	10
16	29	F	Ovarial cancer	C6–T4	Ho C6,7 (claw); pedicle Ho T3,4 (USS)	2.5
17	61	M	Lung cancer	C5–T1	Ho C5,6; Ho/Sc T1	1.5
18	74	M	Prostata cancer	Occ–C3	Sc occ; Ho C3	1
19	65	F	Renal cancer	C5–T4	Ho C5 (claw); Ho T4	0
20	70	F	Breast cancer	C5–T6	Ho C5,7; pedicle Ho T5,6 (USS)	9.5
21	69	M	Prostata cancer	C5–T2	Ho C5, Ho T2	7
22	74	F	Myeloma	Occ–C5	Sc occ, C3; Ho C5	4.5
23	62	F	Spondylitis	C4–T6	Sc C4,5, Sc T5,6; anterior bone graft	1.5
24	74	M	Stenosis-myelopathy	C2–C6	Ho C2,6; Sc C3,5	22.5
25	61	M	Stenosis-myelopathy	C4–T1	Sc C4,5,6,7; Ho T1	26.5
26	55	M	Stenosis-myelopathy	C2–T2	Sc C5,6,7; Ho C2,T2	17

^aThe cervical or thoracic vertebrae used as fixation point

a cervico-thoracic fixation with a long construct connecting Cervi-Fix with a thoraco-lumbar implant (Universal Spine System) was used in two patients with metastasis in the upper thoracic spine (cases 16, 20). The stabilizing levels and implants used are shown in Table 1.

The patients were followed with standardized radiographs immediately after surgery and, at follow-up, flexion/extension radiographs were taken in addition to the standard lateral views. The position of hooks and screws on the postoperative radiographs and the follow-up examination were carefully interpreted to identify implant loosening or breakage.

Outcome parameters were: infection, implant removal, iatrogenic neurological injury, and implant loosening or dislocation assessed by standard and flexion/extension radiographs.

Instrumentation system

Cervi-Fix is a system for posterior fixation of the occipito-cervical spine, upper and lower cervical spine, and upper thoracic spine (Fig. 1). A choice of clamps and hooks are fixed on a rod (3.5 mm) by means of set screws. Bone screws (3.5 mm) can be positioned through the clamps in the desired direction.

A special rod is designed for fixation to the occiput. One end of the rod is flattened to a plate, and it can be contoured and fixed to the occiput with screws. Hooks are available with two offsets. A cross-linking device and parallel connectors are available, allowing connection to rods with the same size or larger diameter rods.

The posterior rod system is more elastic than titanium plates, while dynamic tests of posterior plates and the rod system showed similar results [6].

Results

Traumatic lesions in the cervical spine were treated in 13 patients. One old patient with ankylosing spondylitis and a C7/T1 fracture with severe dislocation (case 12) died within 1 month after surgery, due to myocardial infarction. The remaining 12 patients with traumatic lesions were followed for between 7 and 28 months. One patient without symptoms at follow-up (case 8) refused the offer of follow-up radiography.

All the trauma patients were stabilized with lateral mass screws, as described by Magerl and co-workers [8] or by lateral mass screws combined with laminar hooks (Fig. 2), except for the patients with fracture and ankylosing spondylitis (cases 12, 13), who were fixed only with hooks. In four cases, an additional anterior fusion was performed with tricortical bone graft from the anterior iliac crest, stabilized with an anterior cervical plate in three

Fig.1 The Cervi-Fix implants: **A** small hook; **B** large hook; **C** clamp for C2 screw; **D** clamp for lower cervical spine screws; **E** clamp for pedicle screws; **F** cross-linking clamp; **G** parallel connector 3.5/3.5 mm; **H** parallel connector 3.5/6 mm; **I** cortex screw (self-tapping 3.5 mm); **J** occiput rod; **K** rod

Fig.2 Screw-hook fixation of a C6-7 dislocation (case 11). The fixation in the upper vertebra is performed by insertion of the screw into the lateral masses through the clamp; sublaminae hooks are anchoring the lower vertebra

cases. In patients with dislocations and facet process and/or laminar fractures, the instrumentation was extended to an uninjured level.

The two patients who were neurologically intact, and eight of the nine patients with upper extremity radiculopathies, were normal at follow-up, while one was unchanged. One of the two patients with quadriplegia was unchanged and one was slightly improved.

The patients with myelopathy due to spinal stenosis were followed for between 17 and 26 months. Two of these improved significantly, and one was unchanged. All three were operated on with multilevel decompression and stabilized with lateral mass screws and hooks.

Three of the nine patients with metastasis had involvement of the upper cervical spine, and were stabilized with occipito-cervical fusion. Bone cement was used for additional stabilization in two cases.

A long fixation with a combination of a claw construct in the cervical spine using hooks from the CerviFix and pedicle hooks from the Universal Spine System (USS) in

Fig.3 Cervicothoracic fixation (case 16) with a combination of a claw construct in the cervical spine using hooks from the CerviFix and a stronger implant for the thoracic spine (Universal Spine System)

the thoracic spine was used in two patients with metastasis in the upper thoracic spine (Fig. 3).

One patient (case 19), with metastases from renal carcinoma, died 2 days after surgery due to acute gastrointestinal bleeding and heart failure. The remaining patients had a mean survival of 4.8 months.

One of the patients with ankylosing spondylitis and C7–T1 fracture (case 13) displayed an increased anterior displacement of C7 on T1 about 5 weeks after surgery. One of the upper hooks (C5) did not fully grip the lamina. He was put in to a Halo vest for 2 1/2 months. During this time, the other upper hooks displaced slightly, without losing their grip. No neurological impairment was observed. At the last follow-up, 5 months after the removal of the Halo, no further displacement had occurred.

No implant breakage or radiological or clinical signs of screw or hook loosening was observed in any of the remaining 25 patients. The patient with tuberculous spondylitis had one pedicle screw placed eccentric to the pedicle at the lower end of the instrumentation. At the time of surgery, she had been quadriparetic for about 1 month. There were no neurological or vascular complications related to hook or screw placement. Three wound infections healed on conservative treatment (cases 1, 13, 26).

No implants had to be removed.

Discussion

The surgical stabilization procedure selected in the cervical spine is dependent on the anatomical level involved as well as the pathology. The posterior implant system used in this study is a system for stabilization of the occipitocervical junction and the cervical and upper thoracic spine. The present study includes stabilizing procedures at different anatomic levels as well as in different pathoanatomic lesions, such as trauma, metastases and degenerative disease.

Since Rogers [10] first described cervical wiring techniques, a large variety of modifications have been reported [1, 13], with good results and few complications. However, there are several limitations with the posterior wiring technique and, despite the clinical merits of the construct, it is unsuitable in patients with fractured posterior elements and in metastatic disease with rotational and extension/flexion instabilities. Further, the use of sublamina wires at levels below C3 is an unsafe procedure, and is generally not recommended. The shortcoming of the wiring technique in several clinical situations as well as the superior biomechanical properties of posterior plating [4, 11] is probably the main reason for the increasing popularity of posterior cervical plating [9].

Implant loosening due to poor screw fixation has been reported [7], but this was not seen in our series or in a previous study [6]. One explanation might be that CerviFix, in contrast to posterior plates, allows optimal screw insertion. Another explanation could be the use of hooks, especially at the ends of a long construct. The hooks probably

diminish the pull-out action, and a hook-screw construct might be preferable to using solely screws in older patients with osteoporosis. The use of hooks in the cervical spine has been restricted due to spinal encroachment and the risk of cord compression. Additionally, dislodgement due to weakened bone or extension and torsion movements can occur when the hook is not rigidly fixed to the laminae. The latter could be the reason for the fracture displacement and hook dislodgement in one of our patients. The upper hooks were placed supralaminarly and the lower ones infralaminarly. A claw construct at both ends might have prevented the displacement.

In a recent experimental study with Cotrel Dubouset Instrumentation, Fagerström et al. [3] found no evidence of deformation of the spinal cord in a study of 80 hook sites. Deformation of the dura was observed at four hook sites, and at two of them the hooks were in contact with the spinal cord, but without deformation of the cord.

It is our opinion that hooks are useful to supplement the screw technique, except in patients with a congenitally narrow spinal canal or degenerative spinal stenosis. In these patients, the use of sublamina hooks is contra-indicated. The combination of screws and hooks turned out to be useful in several of our cases, for example in the patients with facet-dislocation, especially at C6–C7 (Fig. 2), as the seventh vertebra is unsuitable for lateral mass screws.

Biomechanical studies have shown that the hook plate is a stable osteosynthesis in both flexion and torsion [12]. The combination of screws and hooks in the present implant system is comparable to hook plates, and consequently there is no reason to believe that the construct with lateral mass screws and sublamina hooks should have an inferior biomechanical quality. We found this construct superior to hook plates [5], as it allows optimal screw insertion and ample bone grafting.

Ten percent of thoracic lesions are metastases of the upper thoracic spine [2]. The upper thoracic spine is a problem area, as it is difficult to reach anteriorly, and it is our experience that posterior stabilization may be challenging as well. The construct used in two of our patients, with a combination of an implant system for the cervical spine and a stronger implant for the thoracic spine, makes possible a construct with long lever arms, which thereby has good biomechanical properties (Fig. 3).

Conclusion

The CerviFix implant system for posterior stabilization of the cervical spine is versatile and seems to be both safe and efficient. Screw fixation and constructs with few hooks are easy to handle, while stabilization with several claw constructs is time consuming due to the lack of an appropriate hook holder.

Acknowledgement Financial support was provided by the University of Umeå and the Swedish Association for Persons Disabled by Traffic Accidents or Cancer.

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