Neurological recovery after occipitocervical fixation

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ABSTRACT

Purpose. To report on 14 consecutive cases of occipitocervical fixation.

Methods. Records of 8 men and 6 women aged 40 to 81 (mean, 57) years who underwent occipitocervical fixation and were followed up for a minimum of 2 years were retrospectively reviewed. Neurological grading was assessed before and after surgery using the Ranawat grade. Intra-operative somatosensory evoked potentials were monitored.

Results. The main indications for surgery were rheumatoid arthritis (n=6) and cervical metastasis (n=4). 77% of the patients demonstrated neurological improvement. Four out of the 5 non-ambulatory patients (Ranawat grade IIIB) regained ambulatory status postoperatively. No patient had neurological deterioration or evidence of vertebral artery or spinal cord injury. One endured a superficial wound infection and 2 had implant breakage.

Conclusion. Although occipitocervical fixation is technically challenging and there are risks of serious neurologic or vascular complications, it remains a viable option with favourable results in patients requiring stabilisation of the craniocervical junction.

Key words: arthritis, rheumatoid; neoplasm metastasis; occipital bone

INTRODUCTION

Occipitocervical fixation refers to instrumentation and fusion of the occiput to any area of the cervical spine. It was first performed by Otfried Forster in 1927 using a fibular strut graft placed from the occiput to the base of the neck for tuberculous spondylitis. Occipitocervical fixation may extend from the upper 2 cervical levels to the lower cervical levels, depending on the extent of the pathologies. These include: trauma, inflammatory conditions such as rheumatoid arthritis and ankylosing spondylitis, primary tumours and metastases, and infections, as well as congenital and developmental anomalies. The main surgical indications are pain, instability, and neurologic compromise. The treatment goals are pain relief, correction or prevention of instability, and decompression of the neural canal.

Initial operative techniques involved onlay fusion, but necessitated prolonged immobilisation in a halo
vest. Occipitocervical fixation confers the advantages of rigid fixation without the use of a halo vest, higher fusion rates, and becoming a salvage procedure for failed non-instrumented occipitocervical fusion.

We report on 14 consecutive cases of occipitocervical fixation, their pathologies, the levels involved, the surgical results, and complications.

MATERIALS AND METHODS

Records of 8 men and 6 women aged 40 to 81 (mean 57) years who underwent occipitocervical fixation between January 2001 and January 2004 were retrospectively reviewed. In patients with atlantoaxial instability and cranial settling, extension of instrumentation to the occiput was indicated. In patients with involvement of tumour or trauma in the subaxial spine, occipitocervical fixation to improve stability was required. Rheumatoid arthritis (n=6, 47%) was the most commonly associated pathology, followed by metastases from breast or lung carcinoma (n=4, 27%) [Table 1]. One patient had a non-union odontoid fracture treated with a Halifax clamp. All 14 patients had pain and 12 of them had evidence of myelopathy. The mean duration of symptoms in patients with rheumatoid arthritis was 15 (4–24) weeks. Neurological grading was assessed before and after surgery using the Ranawat grade1 (Table 2).

All patients underwent rigid occipitocervical fixation with either screws or hooks, together with the use of a rod or plate under general anaesthesia. Intraperoperative somatosensory evoked potentials were monitored. Neutral anatomical alignment to preserve sagittal balance and neutral rotation was ensured. A midline incision was made after subcutaneous adrenaline infiltration from the inion to the spinous process of C7. The occipital bone, foramen magnum, and the facet joints of the vertebrae to be fused were dissected. Dissection of the superior aspect of the posterior C1 arch was kept to within 15 mm from the midline.

Occipitocervical instrumentation used a rigid rod/screw construct in the cervical spine, with the rod converting into a small plate at one end through which bone screws could be placed into the occiput to obtain bicortical purchase near the centre of the occiput (Fig.). In 11 patients the Cervifix system (Synthes; Paoli [PA], US) was used and in 3 the Vertex system (Medtronic Sofamor Danek; Memphis [TN], US). The instrumentation started with the placement of C1/2 transarticular screws. The starting point was about 2 to 3 mm medial and superior to the medial aspect of the C2/3 facet joint. The trajectory was determined by the lateral and anteroposterior fluoroscopy images, ensuring that the screws engaged the mid to upper portion of the C1 anterior arch. This was followed by the placement of subaxial lateral mass screws.2 We placed the starting point slightly medial and inferior to the midpoint of the lateral mass, and created a starting pilot hole with a fine carbide burr (Medtronic Midas Rex; Fort Worth [TX], US). The lateral mass screw was directed in a superior and lateral manner, keeping the trajectory as parallel to the cephalad facet joint as possible. Finally, the rods were contoured and placed on the spine. The occipital screws were placed last.

After occipitocervical instrumentation, posterior C1 arch laminectomy was performed if clinically indicated. In patients with irreducible atlantoaxial subluxation, decompression was performed using a diamond burr under magnification. Attention was paid to not stray >15 mm from the midline of the midpoint of the C1 posterior arch. Autogenous iliac crest bone grafts were then obtained. The fusion bed was burred and packed with morcelised iliac crest graft. A drain was inserted before closure.

Patients stayed in the intensive care unit overnight for monitoring of respiratory function. Leak testing was conducted the following day before extubation. Two patients required external immobilisation wearing a halo vest or hard Philadelphia collar for 3 months.

RESULTS

All patients were followed up for a minimum of

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### Table 1

<table>
<thead>
<tr>
<th>Pathology</th>
<th>No. of patients</th>
</tr>
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<tbody>
<tr>
<td>Rheumatoid arthritis</td>
<td>6</td>
</tr>
<tr>
<td>Metastasis</td>
<td>4</td>
</tr>
<tr>
<td>Trauma</td>
<td>2</td>
</tr>
<tr>
<td>Degenerative myelopathy</td>
<td>1</td>
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<tr>
<td>Infection (tuberculosis)</td>
<td>1</td>
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### Table 2

<table>
<thead>
<tr>
<th>Grade</th>
<th>Features</th>
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<tbody>
<tr>
<td>I</td>
<td>Pain without neurological deficit</td>
</tr>
<tr>
<td>II</td>
<td>Subjective weakness</td>
</tr>
<tr>
<td>III</td>
<td>Objective weakness</td>
</tr>
<tr>
<td>IIIA</td>
<td>Long tract signs</td>
</tr>
<tr>
<td>IIIB</td>
<td>Ambulatory status</td>
</tr>
<tr>
<td>IIIB</td>
<td>Non-ambulatory status</td>
</tr>
</tbody>
</table>

1. Ranawat neurological grades
2. Occipitocervical instrumentation used a rigid rod/screw construct in the cervical spine, with the rod converting into a small plate at one end through which bone screws could be placed into the occiput to obtain bicortical purchase near the centre of the occiput.
2 years. 10 (67%) of the patients demonstrated neurological improvement by one grade. One of the 14 (7%) who had tuberculous spondylitis improved by 2 grades from grade III to I with complete resolution of neurological deficit; none had worsening of their neurological grade (Table 3).

Four of the 5 non-ambulatory (grade IIIB) patients regained ambulatory status after surgery. The remaining patient had metastatic lung carcinoma and died from bronchopneumonia 3 months after surgery. Five of 6 patients with grade I status had minimal to no pain.

Four (27%) patients endured postoperative complications (bronchopneumonia in one, superficial wound infection in one, and implant breakage in 2). None had neurologic compromise or vascular complications.

DISCUSSION

Pathologies affecting the craniocervical junction include: traumatic and pathological fractures from metastases, inflammatory conditions (such as rheumatoid arthritis), infections, and congenital and developmental anomalies. In our series, rheumatoid arthritis and tumours were the most common indications, similar to findings by others.3-5

Onlay fusion techniques did not include any instrumentation and required rigid external fixation with a prolonged use of a halo vest. Halo vests were tolerated especially badly in the elderly population.6 Internal fixation techniques offer several advantages, namely easier nursing care, earlier mobilisation and ambulation, and a higher union rate. The techniques include occipital and sublaminar wiring and the use...
of a rectangular rod, occipital screws and C2 lamina claw hooks and rod, occipital screws and C1-C2 transarticular screws and rod, occipital screws and C1-C2 transarticular screws and Y-plate, as well as occipital screws and C2 pedicle screws and rod. In a cadaveric biomechanical test comparing these 5 fixation methods, C1-C2 transarticular screws or C2 pedicle screws conferred superior results on axial rotation, flexion/extension, lateral bending, and anterior-posterior translation. The fusion rates of these methods were about 100%.\(^3\)\(^4\)\(^5\)

11 of our 14 patients had neurological improvement, which was comparable to other studies reporting improvement in symptoms in 75 to 92% of patients and neurological improvement in 30 to 40%\(^3\)\(^4\)\(^5\). In one series, however, of 55 patients with rheumatoid arthritis and cervical myelopathy graded as Ranawat grade IIIB, 33 remained non-ambulatory after surgery, with a 58% mortality after 33 months of follow-up. In this group of patients, therefore, recovery of neurological function appeared irreversible and the overall surgical results were dismal and life expectancy was minimal. Of 13 patients followed up for a mean of 3.6 years after occipitocervical fusion, all 10 patients with myelopathy improved, but of the 4 that were non-ambulatory, only one was able to walk postoperatively. Occipitocervical fusion should be undertaken before severe myelopathy occurs, as recovery is poor in non-ambulatory patients. In our series, 4 of 5 non-ambulatory patients regained ambulatory status postoperatively. This suggests that surgery may be a viable option for non-ambulatory patients with craniocervical pathologies.

In our series, one (7%) patient had a superficial wound infection. Moreover, none developed an infection in the bone graft harvest site, which was comparable to the 5% rate reported by others.\(^3\) Vertebral artery injury was reported in 2 out of a series of 67 paediatric patients\(^4\) and 5 out of a series of 191 adult patients.\(^5\) In our series, no injuries to the vertebral artery or spinal cord were encountered. All our patients had somatosensory evoked potentials monitored intraoperatively. Fusion rates were consistently good,\(^3\)\(^4\)\(^5\) and no obvious pseudarthrosis was noted on plain radiographs. Up to 25% of the patients had degeneration of the adjacent level of spine at 10-year follow-up.\(^1\)\(^2\)\(^13\) Most of our patients were followed up for 2 to 5 years, at which time none complained of symptoms suggestive of degeneration of the adjacent level of spine.

Our study was a retrospective review of patients with mixed diagnoses and fixation was assessed based on plain radiographs (in flexion/extension views). Computed tomography should have been used to more accurately confirm bony fusion. Occipitocervical fixation is effective in stabilising the craniocervical junction caused by various pathologies. It has a high fusion rate thereby confers good outcomes, but risks serious complications, such as vertebral artery and spinal cord injuries. Non-ambulatory patients may also benefit from the surgery.

REFERENCES