ABSTRACT

Purpose. To compare the use of the halo fixation device in our hospital before and after implementation of a new compliance protocol.

Methods. From 2003 to 2008, 17 (47%) of 36 patients had dislodgement of their halo fixation device. All rings and vests and some of the pins were reused. Documentation of poundage assessment and change of skull pins before dislodgement was lacking. There was no protocol for assessing superstructure throughout the course of the application. To improve the standard of care, knowledge about the application of the halo fixation device in orthopaedic and orthotic departments was reinforced and compliance documented. From September 2008 to April 2010, 15 patients used the halo fixation device for cervical immobilisation. Patients were reminded to minimise shoulder shrugging and report any discomfort. Poundage checking was strictly observed during and after application. The integrity of the device was regularly checked by orthotists. The conditions of the skull pins, halo ring, and vest were also documented after removal.

Results. Two (13%) of the 15 patients had ring dislodgement. One occurred a day after application owing to malposition of a posterior skull pin, and the other was related to a fall in a toilet at week 4. Both involved reused skull pins. 45% of the skull pins were new, whereas 44% were found defective after removal of rings. Compliance with the new assessment form was satisfactory.

Conclusion. Clinical audit improved outcome achieved with the halo fixation device. Reuse of titanium skull pins should be avoided. Re-torquing of the pin should be avoided when the tip is blunted or hooked. The new assessment form enabled compliance with the principle of application by orthotists and patients.

Key words: clinical audit; external fixators; orthopedic fixation devices

Monitoring the use of halo fixation device through an assessment form

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INTRODUCTION

Despite advances in internal fixation of cervical vertebrae, the halo fixation device remains useful for cervical immobilisation and as an adjunct to internal fixation. It enables fine adjustment of alignment and better feeding (owing to the absence of skin impingement at mandible).1-3 Its design and materials have been improved to enable better tolerance by patients. Its materials (titanium, carbon fibre, and plastic) are compatible with magnetic resonance imaging.4 Nonetheless, titanium is less durable than stainless steel; the conical skull pins can be easily blunted after repeated use (Fig.); they penetrate 1-2 mm into the skull and the stress is distributed to the bone surrounding the pin tips.5 Skull pin poundage of 8 in-lbs is recommended at the start of application,6-8 and if re-torquing is necessary it should be lower to 3 in-lbs at week 3 so as to avoid overpenetration.9 This inevitably lowers the gripping force on the skull.10

The device is usually reused, as new pins and a vest of appropriate size are not readily available in cases of cervical trauma. The vest may not fit, and the superstructure and its components may break after repeated use. Therefore, monitoring the use of the halo fixation device is important to avoid complications. 36% of complications entail pin loosening and 20% are pin site infections.11-13 6% of the patients underwent removal of the device11; 3% had dislodgement of the ring, which can be dangerous as the cervical spine is not adequately protected and the pins may cause eye injuries.12 We compared the use of the halo fixation device in our hospital before and after implementation of a new compliance protocol.

MATERIALS AND METHODS

In our hospital from 2003 to 2008, 17 (47%) of 36 patients had dislodgement of the halo fixation device (Table 1). The device was applied by orthopaedic trainees or specialists. All rings and vests and some of the pins were reused. Documentation of poundage assessment and change of skull pin before dislodgement was lacking. There was no protocol to assess the superstructure throughout the course of its application.

To improve the standard of care, knowledge about application of halo fixation device in orthopaedic and orthotic departments was reinforced. The indications, the matching of the ring and vest to the skull and body circumference, the poundage of skull pins during application, any complication, and any defect in the reused skull pins were all documented. Suggestions on the number and poundage of the skull pins for use in different age groups was provided, as was information on appropriate weights for halo traction.

From September 2008 to April 2010, 15 patients used the halo fixation device for cervical immobilisation (Table 2); 11 used it as definitive treatment and 4 as an adjunct to internal fixation for 87 (range, 57–127) and 52 (range, 1–79) days, respectively. The device was applied by orthopaedic trainees under supervision or by orthopaedic specialists in order to ensure a suitable ring position, balanced application of skull pins, and cervical

![Figure](image_url) The conical tips of skull pins.

### Table 1
Use of the halo fixation device from 2003 to 2008

<table>
<thead>
<tr>
<th>Indication</th>
<th>Ring dislodgement (no. of patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Cervical myelopathy with kyphosis</td>
<td>0</td>
</tr>
<tr>
<td>Infection</td>
<td>4</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>1</td>
</tr>
<tr>
<td>Down's</td>
<td>1</td>
</tr>
<tr>
<td>Tumour</td>
<td>1</td>
</tr>
<tr>
<td>Trauma</td>
<td>4</td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 2
Use of the halo fixation device from September 2008 to April 2010

<table>
<thead>
<tr>
<th>Indication</th>
<th>No. of patients used the halo fixation device as</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definitive treatment</td>
</tr>
<tr>
<td>Cervical fracture</td>
<td>9</td>
</tr>
<tr>
<td>Multiple myeloma</td>
<td>1</td>
</tr>
<tr>
<td>Septic spondylitis of C1/2</td>
<td>1</td>
</tr>
<tr>
<td>Cervical myelopathy</td>
<td>0</td>
</tr>
<tr>
<td>Traumatic central cord syndrome</td>
<td>0</td>
</tr>
</tbody>
</table>
alignment. Integrity of new and reused skull pins and the screw tract of the reused halo ring was examined by orthotists to ensure smooth application. Patients were reminded to minimise shoulder shrugging and report any discomfort. Poundage checking was strictly observed during and after (24 to 48 hours and one week) application. Dressing for the pins was given every alternate day. The integrity of the device was regularly checked by orthotists. The conditions of the skull pins, halo ring and vest were documented after removal. Antibiotics were prescribed for pin site infection; skull pins were changed if pain persisted after antibiotic treatment. During checking of poundage, further screw-in of the pin for >2 turns was not advised so as to prevent excessive penetration.

RESULTS

Two (13%) of the 15 patients had ring dislodgement. One occurred a day after application owing to malposition of a posterior skull pin, and the other was related to a fall in a toilet at week 4. Both involved reused skull pins.

45% of skull pins were new. 44% of skull pins were defected after removal of the rings. For reused pins, the tip was blunted as early as one day after application. In a patient with a myeloma at the thoracolumbar junction who had a second ring removed after 18 days (because of intolerable thoracolumbar pain), 3 of the 4 pins were found to be blunted. In new pins, a defect was detected as early as 4 weeks.

One patient had pin site infection, which was treated with oral antibiotics. Compliance of the new assessment form was complete in 12 of 17 applications. In 5 patients, checking of poundage was missed at week 1. Checking of superstructure was complete in 15 of the 16 applications. Communication between orthopaedic surgeons and orthotists should have been enhanced to increase compliance.

DISCUSSION

The early fatigue of titanium conical pins indicated that reused pins are not reliable for the entire course spanning 8 to 12 weeks. Even new pins could be blunted at week 4. Reuse of skull pins should be avoided. The halo rings and vest can be reused after careful examination to exclude any defect. The yield strength of titanium is low.5 Micro fractures of the outer cortex of the skull could occur and creep around the pin tip when conical pins were inserted,5,14 and result in pin loosening. When a blunted or hooked tip was rotated during the checking of poundage, during routine re-torquing, or owing to pin site pain, the surrounding bone is ground further, the pin becomes looser, and the risk of penetrating the inner cortex increases. The routine practice of re-torquing skull pins beyond 3 weeks should be revised. When the pin tip is deformed after a few weeks of application, it should be changed rather than re-torquing whenever patients have pin site pain. Antibiotics should be given first for low-grade infection. The new design of the trochar tip seems to decrease the rate of pin loosening, compared to the conical tip.13 Materials composing both titanium and ceramic have been used to increase pin hardness while retaining compatibility with magnetic resonance imaging.

Multidisciplinary cooperation is needed to minimise complication when using the halo fixation device for cervical immobilisation. The new assessment form facilitates compliance with the principles of application by orthotists and patients.

REFERENCES