THE "HALO" TRACTION APPARATUS
A Method of External Splinting of the Cervical Spine after Injury

HARRAL THOMPSON, MANCHESTER, ENGLAND

From the University Department of Orthopaedic Surgery, Manchester Royal Infirmary

External fixation of the cervical spine is usually obtained by means of a "Minerva" plaster-of-Paris jacket, a device by no means always satisfactory. The patient usually finds it heavy, and frequently hot and uncomfortable. Even the best fitting "Minerva" plaster allows more cervical movement than the surgeon may desire, and though immobilisation may be improved by the incorporation of a skull caliper in the plaster, as suggested by Blockey and Purser (1956), the caliper may work loose after a few weeks. Radiographic examination of the cervical spine through a plaster-of-Paris jacket is difficult, and adjustment of the position of the head or neck is impossible once such a plaster is applied. If an unstable spine is to be exposed at operation, a "window" in a "Minerva" plaster gives all too little room, especially in the depths of a fat neck, and such explorations have usually to be performed without the safety of rigid fixation of the neck during anaesthesia and operative manipulation.

It follows that a method which overcomes any or all of these difficulties is of value. Perry and Nickel (1959) devised and described the use of a device for cervical fixation which they called the "halo" traction apparatus. They used it for control of the unstable paralysed neck and upper thoracic spine, but did not suggest its use in other circumstances. James (1960) reported a single case of fracture-dislocation of the cervical spine treated by means of a "halo" splint somewhat modified from the original design. The "halo" traction apparatus has now been in use in this department for nearly two years. The following is a description of the apparatus and its method of application, together with a record of eleven patients who have been treated in it.

DESCRIPTION OF THE "HALO" TRACTION APPARATUS

The appliance consists of a jointed adjustable steel frame which is incorporated in a plaster jacket in such a way that the neck is free from plaster. The adjustable steel frame comprises the following parts. 1) A U-shaped metal bracket (Fig. 1a) which is fixed to the shoulder straps of a plaster jacket extending from the shoulders to the iliac crests. The transverse bar of the U-shaped bracket is adjustable laterally, and may be locked in any desired position by means of two screws. The vertical bars of the U-bracket are malleable to conform to the shape of the shoulder straps of the plaster jacket, and each bar carries a vertical socket. The bracket is perforated at intervals to allow it to be screwed, if desired, to the plaster jacket; we have not found this necessary. There are, in addition, a number of small bosses on the bracket to allow a firm grip to be obtained on it by the plaster bandages used to fix it to the plaster jacket. 2) A steel superstructure consisting of two angled vertical rods (Fig. 1b) which fit into the vertical sockets on the bracket, and whose vertical position can be adjusted by cylindrical adjustable stops (Fig. 1f) on the rods. The upper end of the vertical rods are fixed into an adjustable rectangular frame (Fig. 1c) which has three transverse bars, the anterior and middle of which carry the three supporting arms of the "halo," while the posterior bar is used to give rigidity to the steel superstructure. 3) The "halo" splint, an oval steel band arched upwards posteriorly (Fig. 1e) to clear the occipital area. At 2, 4, 6 and 8 o'clock it has sets of three screw holes (Fig. 1g) through which are passed the screws by which fixation to the skull is obtained. The three screw holes at each point allow some choice.
in the position of the skull screws to fit the individual skull, and allow others to be inserted should the original screw work loose or become infected, without having to adjust the position of the whole "halo" on the skull. The skull screws are designed to allow perforation of the outer table of the skull only, and will cut through the skin without an incision having been made. The "halo" is fixed by three supporting arms (Fig. 1d) to the rectangular frame which lies horizontally above the head. The anterior supporting arm, which is threaded at both ends, hangs from the anterior transverse bar; it is straight, and it fits into a hole anteriorly in the "halo" where it is fixed by two locking nuts. The two postero-lateral supporting arms, which are threaded at their upper ends, hang from the middle transverse bar of the frame, and are curved outwards as they descend, to fit the contour of the skull. They are attached to the "halo" by perforations in their lower ends, which slip over small projecting horizontal bars on the "halo." All three supporting arms can be adjusted vertically by a knurled thumb screw threaded on their upper ends, which can be fixed by a locking nut.

Adjustment of the position of the "halo" can be made anteriorly and posteriorly by alteration of the position of the anterior and middle transverse bars of the rectangular steel frame. Lateral adjustment and, within fine limits, rotational adjustment may be made by altering the position of the supporting arms on their transverse bars. Vertical adjustment, within coarse limits, may be made by adjustment of the height of the vertical angled rods, and within fine limits, by adjustment of the supporting arms of the "halo." After any necessary adjustment of the position of the "halo" has been made, all movable parts are locked by means of grub nuts, with the exception of the supporting arms, where fixation is obtained by locking nuts.

**Method of application**—The apparatus is applied in two stages. First the plaster jacket is made; and secondly the steel frame is fitted to the plaster jacket and to the skull.

*The plaster jacket*—It is essential during the application of the plaster jacket to have adequate control of the unstable spine, and this is most conveniently achieved by Crutchfield calipers. With adequate control of the cervical spine it is possible to get the patient sitting on a stool, vertical traction being maintained from an overhead hook suspended from a gallows or from the ceiling. The plaster jacket is applied in this position.

Two points in the application of the jacket require emphasis. First, the jacket must be brought down below the level of the iliac crests and accurately moulded to them, and secondly, it is essential that the shoulder straps be of adequate strength to carry the bracket and that they be well padded. The padding used may be sorbo rubber or orthopaedic felt, and should be about one and a half inches in depth (Fig. 2).
After the application of the jacket the patient is returned to bed, control of the cervical spine being maintained by means of the skull calipers.

Fitting the apparatus—The metal frame may be fitted as soon as the plaster jacket is sufficiently dry, usually after about forty-eight hours. Accurate positioning of the patient is essential. He should lie with the shoulder pieces of the plaster jacket projecting over the end of the operation table (it is not necessary to use an operation table if the bed on which the patient lies has a removable headpiece).

Control of the cervical spine is maintained manually by an assistant who is seated, and who applies horizontal traction. Greater ease in the application can be obtained by use of an occipital head rest (Fig. 3) in addition to manual traction. It steadies the head while the "halo" is screwed to the skull, and the steel superstructure is erected and fixed. The use of an occipital head rest is, however, not essential.
The skin of the shaven head is then prepared. The operator and his second assistant should be scrubbed up. The operator first takes the "halo" splint, which has previously been sterilised, and advances the screw in each quadrant about half an inch through the selected screw hole. It is convenient to use the middle of the three holes initially, although other holes may have to be used to get an adequate grip on the skull. The "halo" splint is then grasped by the second assistant at the front and at the back, slipped over the skull and positioned by the operator. It is placed coronally around the skull, that is, horizontally when the patient will be vertical, and sited below the equator of the skull. With the "halo" in position the point of penetration of the screws into the skull should be marked by sighting along the previously advanced screws, and marking the points on the scalp with a dye such as Bonney's blue. The "halo" is now slipped off the skull, and the marked points of entry of the skull screws are injected with two or three millilitres of 2 per cent Lignocaine. After an interval to allow anaesthesia to be obtained, the "halo" is again slipped on to the head, and all the screws are advanced until they touch the skin at the previously marked points; the screws should be so adjusted that the "halo" lies symmetrically around the skull. The screws are now advanced with a screwdriver, and this is best done by advancing them in diametrically opposed pairs, the screws being driven in simultaneously by the operator and his second assistant, each pair of screws being advanced a short way alternately. Firm resistance to rotation of the screws indicates that they have been driven home, and a firm pull on the "halo" will confirm this.

The steel superstructure is then assembled and attached to the "halo." The bracket is next fixed to the plaster jacket with plaster bandages, supplemented by screws if desired. The position of the "halo" should be adjusted to the desired position of the cervical spine or skull. Ideally, if the position of the "halo" has been well chosen it should then lie parallel with the overhead adjustable frame. All movable parts of the apparatus should be locked by tightening the locking nuts and grub nuts. The patient may now sit up in bed, but before he is allowed to walk it may be necessary to readjust the apparatus, because some sinking of the plaster jacket may occur when he stands, with consequent dropping of the "halo" and loss of position of the skull or cervical spine. The skull calipers, if used, should not be removed until this final adjustment has been made.
FIG. 5
Case 5—Initial radiographs, showing fracture of the body of the axis with forward and lateral subluxation of the atlas on the axis.

FIG. 6
Case 5. Figure 6—Radiograph with the patient in the "halo" traction apparatus. The fracture is in good position and the subluxation of the atlas on the axis is reduced. Figure 7—Radiograph after removal of the "halo" traction apparatus.
### TABLE I

**CLINICAL DETAILS OF ELEVEN PATIENTS**

<table>
<thead>
<tr>
<th>Case number</th>
<th>Age (years)</th>
<th>Lesion of cervical spine</th>
<th>Cause</th>
<th>Period in &quot;halo&quot;</th>
<th>Complications</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35</td>
<td>Atlanto-axial subluxation</td>
<td>Ankylosing spondylitis</td>
<td>47 days</td>
<td>Anterior skull screws slipped twice. &quot;Halo&quot; reapplied at 19th day</td>
<td>Apparatus applied too high on skull. No slipping after reapplication. Good result</td>
</tr>
<tr>
<td>2</td>
<td>55</td>
<td>Fractured odontoid and arch of atlas with atlanto-axial subluxation</td>
<td>Trauma</td>
<td>71 days</td>
<td>—</td>
<td>Bony union in good position</td>
</tr>
<tr>
<td>3</td>
<td>59</td>
<td>Forward subluxation of C.4 on C.5</td>
<td>Trauma</td>
<td>73 days</td>
<td>One screw hole infected. All screws required tightening at 35th day</td>
<td>Infection of screw hole was slight, and it was not necessary to replace screw. Good result</td>
</tr>
<tr>
<td>4</td>
<td>54</td>
<td>Atlanto-axial subluxation</td>
<td>Rheumatoid arthritis</td>
<td>100 days</td>
<td>—</td>
<td>Occipito-cervical fusion performed in &quot;halo.&quot; (General condition very poor. Suppurative arthritis of both wrists and elbows.) Good result</td>
</tr>
<tr>
<td>5</td>
<td>78</td>
<td>Fractured body of axis with atlanto-axial subluxation</td>
<td>Trauma</td>
<td>82 days</td>
<td>—</td>
<td>Bony union in good position</td>
</tr>
<tr>
<td>6</td>
<td>49</td>
<td>Chordoma C.4</td>
<td>—</td>
<td>86 days. (Home at 44th day)</td>
<td>Vertical rods required adjusting when patient got up out of bed</td>
<td>Radiotherapy given while in &quot;halo&quot;</td>
</tr>
<tr>
<td>7</td>
<td>74</td>
<td>Fractured odontoid</td>
<td>Trauma</td>
<td>73 days</td>
<td>All screws required tightening at 54th day</td>
<td>Apparatus removed earlier than planned because of pneumonia; nevertheless good result</td>
</tr>
<tr>
<td>8</td>
<td>65</td>
<td>Pathological fracture of odontoid with atlanto-axial subluxation</td>
<td>Metastases from carcinoma of colon</td>
<td>11 days</td>
<td>—</td>
<td>Patient walking around in complete comfort until sudden collapse and death on eleventh day</td>
</tr>
<tr>
<td>9</td>
<td>39</td>
<td>Forward subluxation C.4 on C.5</td>
<td>Trauma</td>
<td>85 days. (Home at 9th day)</td>
<td>All screws required tightening at 56th day</td>
<td>Good result</td>
</tr>
<tr>
<td>10</td>
<td>59</td>
<td>Atlanto-axial subluxation</td>
<td>Rheumatoid arthritis</td>
<td>7 days</td>
<td>—</td>
<td>Patient refused further immobilisation in apparatus. Patient mentally disturbed</td>
</tr>
<tr>
<td>11</td>
<td>59</td>
<td>Atlanto-axial subluxation</td>
<td>Ankylosing spondylitis</td>
<td>98 days. (Home at 32nd day)</td>
<td>Anterior skull screws slipped at 42nd day</td>
<td>Fixation renewed by using alternative screw holes. Occipito-cervical fusion performed in &quot;halo.&quot; Good result</td>
</tr>
</tbody>
</table>

**Patients treated**—So far, we have treated eleven patients with cervical spinal injuries with the "halo" apparatus. Their details are shown in Table I. The oldest was seventy-eight years old, the youngest thirty-five. Four were examples of more or less spontaneous atlanto-cervical subluxation in rheumatoid arthritis or ankylosing spondylitis. Two had destructive lesions due to malignant disease of the cervical column, one with pathological fracture and another with instability after a rather radical biopsy. The other five were cases of uncomplicated traumatic fracture-dislocation or dislocation. One patient (Case 10) refused to remain in the "halo" for more than seven days. She was a recognised psychopath who went on to refuse any form of treatment for her atlanto-cervical subluxation other than a cardboard collar.
She left the hospital and has never been seen by us since. Another patient (Case 8) with cervical metastases from a caecal carcinoma died from the disease eleven days after application of the "halo." The other nine patients wore the "halo" splint without complaint for periods varying between forty-seven and a hundred days. Perry and Nickel (1959) reported its use for as long as ten months, during which time all the skull screws were changed once.

The first patient on whom we used the "halo" splint was the only patient who had to have it reapplied because of repeated slipping of the anterior skull screws. Slipping of the anterior skull screws occurred in one other patient after forty-two days, and fixation was regained by using another screw in one of the alternative holes. The patient suffered no harm as a result of these happenings. In three patients all the skull screws had to be tightened, at the thirty-fifth day in one, at the fifty-fourth day in another and at the fifty-sixth day in the third. The adjustment was a minor one in all cases, and no patient required a second tightening of the skull screws.

In one patient a screw hole became infected, but the infection was successfully controlled by local application and it was not necessary to replace the screw.

Sepsis has never forced us to remove the apparatus. Perry and Nickel (1959) had to remove the apparatus on only two occasions in the treatment of sixty-three poliomyelitic patients, and then only after two to three months of use. All our screw holes, including the infected one, healed rapidly after the removal of the skull screws, without conspicuous scarring. Healing was more rapid than in the holes made by the skull calipers, possibly because the skull screws of the "halo" leave a shallow saucerised cavity rather than a buried track.

Two patients had posterior occipito-cervical fusions performed while in the "halo" splint. No difficulties were presented by the splint. The fixation of the cervical spine added to the ease of operation, and movement of the patient on and off the operation table was easier and safer than if fixation had been maintained by skull calipers.

One patient was given radiotherapy for a chordoma of the fourth cervical vertebra while in a "halo" splint. No technical difficulty was reported by the radiotherapist.

Apart from the patient who refused further treatment, no serious complaints were received from any patient; all were up and about on the second or third day after application of the apparatus, and, as we gained courage, patients were allowed to go home, reporting fortnightly for supervision. Because of the height of the superstructure, one of our latter patients—a rather tall man—reported some difficulties with doorways and staircases at home.

Experience with even this small group of patients has convinced us that the apparatus is the best technique we know for the immobilisation of the injured cervical spine. Perry and Nickel (1959) have already shown its value in controlling the paralysed neck; we find it invaluable in broken necks and also in holding a cervical spine that requires posterior fusion.

**SUMMARY**

1. The "halo" traction apparatus and its method of application are described in detail.
2. Its use in nine patients with subluxation or fracture-dislocation of the cervical spine, and in one patient with extensive vertebral disease, is recorded.
3. The indications for using the "halo" traction apparatus are outlined.

I should like to express my thanks to Mr D. Ll. Griffiths for his help in the preparation of this paper.

**REFERENCES**

