S. M. H. Mehdián
B. J. C. Freeman
P. Licina

Cervical osteotomy for ankylosing spondylitis: an innovative variation on an existing technique

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S. M. H. Mehdián (✉) · B. J. C. Freeman
P. Licina
The Centre for Spinal Studies
and Surgery, University Hospital,
Queen's Medical Centre, Nottingham,
NG7 2UH, UK
e-mail: smehdian@prima.net,
Tel./Fax: +44-115-970 9013

Abstract Ankylosing spondylitis can produce severe fixed flexion deformity in the cervical spine. This deformity may be so disabling that it interferes with forward vision, chewing, swallowing and skin care under the chin. The only treatment available is an extension osteotomy of the cervical spine. Existing techniques of cervical osteotomy may be associated with risk of neurological injury. We describe a variation on an existing technique, which provides a controlled method of reduction at the osteotomy site, eliminating sagittal translation. The method employs a modular posterior cervical system consisting of lateral mass and thoracic pedicle screws linked to titanium rods. Our technique substitutes

the titanium rod with a temporary malleable rod on one side, allowing controlled reduction of the osteotomy as this rod bends and slides through the thoracic clamps. Once reduction is complete definitive contoured rods are inserted to maintain the correction while fusion takes place. This method appears less hazardous by eliminating sagittal translation, and may reduce the risk of neurological injury during surgery. It achieves rigid internal fixation, obviating the need for a halo vest in the postoperative period.

Key words Cervical osteotomy · Ankylosing spondylitis · Internal fixation

Introduction

Ankylosing spondylitis may in some individuals produce a severe fixed flexion deformity of the cervical spine. The characteristic “chin on chest” deformity can cause marked restriction of forward vision and interfere with chewing, swallowing and shaving. If ankylosis is *incomplete* on radiographs then closed correction with traction, and fusion without osteotomy maybe applicable [4]. However in advanced disease, cervical osteotomy by posterior, anterior or a combined approach is the only available means of correcting such deformity [1, 6–8]. The first report regarding the surgical correction of flexion deformity in the cervical spine probably appeared in 1953 [4]. In 1958 Urist described a similar technique performed under local anaesthesia with the patient in the sitting position [9]. In

1962 Law described ten patients undergoing cervical osteotomy under general anaesthesia with one death [2]. Simmons followed the recommendations of Urist, highlighting the advantages of an awake patient in providing the most accurate form of spinal cord monitoring [7]. In 1997 McMaster reported on a series of 15 patients undergoing extension osteotomy at C7/T1 under general anaesthesia, with one patient developing quadraparesis and two others developing unilateral palsy of the C8 nerve root [3].

We describe a variation on an existing technique [7, 8], which provides a controlled method of reduction at the osteotomy site thereby preventing translation. This method may be less hazardous in terms of neurological injury, achieves rigid internal fixation and eliminates the need for a halo vest postoperatively.

The technique

Surgery is performed under general anaesthesia, with an awake fiberoptic endotracheal intubation. The spinal cord is monitored ideally with both somato-sensory and motor evoked potentials. A halo ring is applied and the patient placed in the prone position with the head resting on a horseshoe frame. The cervical and upper thoracic spine is exposed through a standard posterior midline approach. Holes are drilled in the lateral masses from C3 to C6 and into the pedicles from T2 to T5 (Fig. 1 a). An image intensifier is used to check screw position. The posterior osteotomy is carried out according to the technique described by Simmons [7, 8]. The inferior lamina of C6, the whole lamina of C7 and the superior part of the lamina of

Fig. 1 a-f Osteotomy sequence. **a** Lateral mass and pedicle screw holes with planned resection. **b** Resection of posterior elements and decompression of C8 roots. **c** Unilateral insertion of clamps with malleable rod on left side. **d** Reduction of osteotomy with bending and sliding of malleable rod. **e** Insertion of clamps and definitive rod on right side. **f** Lateral appearance of completed osteotomy with definitive rods

Fig. 2 Preoperative clinical appearance **A** from the side, **B** from behind

Fig. 3 Postoperative clinical appearance **A** from the side, **B** from behind

Fig. 4 Postoperative radiographs: **A** lateral, **B** anteroposterior. Positioning of screws lateral to the pedicle was without clinical consequence

Fig. 5 Lateral radiograph at 18 months shows maintenance of correction

T1 are removed in accordance with the pre-operative plan. The C8 nerve roots are decompressed to prevent impingement upon closure of the osteotomy site (Fig. 1 b). Lateral mass and pedicle screws are then inserted on the left side. However, instead of using the standard rod for the Cervi-Fix implant (Synthes), a previously sterilised malleable intubation stylette (size WW Make Pty) is used (Fig. 1 c). This rod is fixed to the cervical clamps, but allowed to slide freely within the thoracic clamps. The surgeon then gently closes the osteotomy by grasping the halo ring and extending the neck, allowing the hinge of sagittal motion to occur in the rod, which is close to the posterior longitudinal ligament, the ideal centre of rotation. Meanwhile the assistant guides the malleable rod through the thoracic clamps with a rod holder (Fig. 1 d), and when the desired correction has been achieved, tightens these thoracic clamps. The headrest is adjusted to support the new position. A titanium rod is then contoured for the right side and fixed to the spine with appropriate clamps (Fig. 1 e). The temporary rod on the left is removed and replaced with a second, appropriately contoured, titanium rod (lateral view Fig. 1 f). Decortication is performed from C3 to T4 and bone graft harvested from the posterior iliac crest is laid down posteriorly. The wound is closed and the halo is removed. Postoperatively, the patient is immobilised in an occipito-cervical thoracic orthosis for a period of 3 months until a sound fusion is obtained.

Case report

A 39-year-old male with ankylosing spondylitis presented with severe fixed flexion deformity of the spine. He was treated initially with multi-level extension osteotomy of the lumbar spine. His posture improved, but a marked restriction of forward gaze persisted (Fig. 2). The patient was offered a posterior extension osteotomy of the cervical spine. The chin-brow to vertical angle measured 60°C. This angle was transposed to the lateral radiograph centred over the C7-T1 level, and the amount of bone resection to achieve full correction marked on the radiograph in the pre-operative plan. The patient underwent an extension osteotomy of the cervical spine using the above technique. Our patient suffered no neurological complications. His forward gaze improved dramatically (Fig. 3). Postoperative radiographs are shown (Fig. 4). Radiographs taken at 18 months showed maintenance of correction with evidence of solid bony fusion (Fig. 5).

Discussion

In patients with ankylosing spondylitis it is essential to recognise the primary site of deformity. Consideration should always be given to the hip and the lumbar spine in those with an overall flexed posture. Indeed, surgery in the form of hip arthroplasty and multi-level lumbar osteotomies can be very rewarding.

Less frequently, the major deformity is at the cervico-thoracic junction and extension osteotomy of the cervical spine may be the only effective method of correcting this. The site of election for this osteotomy is at C7/T1, because of the more favourable disposition of the spinal canal, spinal cord, nerve roots and vertebral artery. At this level the canal is relatively wide, damage to the C8 nerve roots is less detrimental to hand function than damage to other nerve roots and the vertebral arteries pass anterior to the transverse process of C7, being less likely to kink when the neck is extended.

There are many methods described for performing cervical osteotomy. Urist describes a case performed under local anaesthesia with the patient in the sitting position [9]. This avoids a potentially hazardous endotracheal intubation and also allows continuous intra-operative monitoring of spinal cord and nerve roots. Simmons reports a large series based on this technique. However, at the point of correction the patient is given a brief anaesthetic (either brevital sodium or propofol), thereby losing spinal cord monitoring, albeit momentarily [8]. Simmons reports one intra-operative cord compromise and one case of non-fatal cardiac arrest early on in his series [7]. There are some disadvantages with this technique: lack of airway control in the event of a sudden complication, lack of control at the osteotomy site during correction and fixation to the halo, risk of air embolism and patient discomfort. The addition of fentanyl and midazolam to supplement local anaesthesia has reduced the amount of lignocaine and adrenalin required, thereby reducing the risk of lignocaine toxicity [8]. In 1962 Law described ten patients who underwent cervical osteotomy under general anaesthesia, with one death [2]. In 1997 McMaster described a series of fifteen patients treated with an extension osteotomy at C7/T1 under general anaesthesia, with one patient developing quadraparesis and two others developing a unilateral palsy of the C8 nerve root [3].

Many series describe manipulation of the halo ring to correct the head position after osteotomy. Shimizu uses an internal fixation device during reduction in the form of a prebent Hartshill rectangle with sublaminar wires [6]. This method conceivably introduces some control in the reduction manoeuvre, but has the risk inherent with the use of sublaminar wire at the cervico-thoracic junction. All authors rely on the halo vest for fixation; even Shimizu supplemented his internal fixation with a halo vest. The halo vest does not provide rigid immobilisation at the osteotomy site, and the potential for subluxation and failure of fusion can be all too apparent. Simmons reported non-union in four patients, all requiring further surgery [7], and McMaster re-operated on two patients for significant subluxation [3].

We believe our current technique for extension osteotomy in the cervical spine has a number of advantages over previously described techniques. Advances in awake fiberoptic intubation mean patients can safely be intubated. In our experience the use of continuous somato-sensory evoked potentials and the addition of motor evoked potentials is a reliable way of monitoring both columns in the spinal cord and the cervical nerve roots. Safely positioning the patient in the prone position with a secure airway under general anaesthesia is clearly advantageous to both the patient and the surgeon. There is little published on the use of a pedicle screw and rod system to hold the osteotomy while bony fusion takes place. Malposition of such screws may in fact produce neurologic injury, and great care should be taken with their insertion. Our application of the temporary rod, allowing this to slide through thoracic clamps during the closure of the cervical osteotomy, ensures a controlled reduction preventing translation in the sagittal plane, and may reduce the risk to the spinal cord. Achieving rigid internal fixation of the cervico-thoracic spine may reduce the risk of subluxation and pseudarthrosis formation and allows the patient to be mobilised without the need for a halo vest. Whilst we accept osteotomy of the cervical spine remains a technically demanding and potentially dangerous operation, we feel our technique does much to increase safety during the reduction manoeuvre and provides a reliable fixation while fusion takes place.

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