Cervical osteotomy in Ankylosing Spondylitis

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Published online: 16 November 2012
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Keywords Cervical osteotomy · Ankylosing spondylitis · Deformity · Correction · Complication · Safety

Learning targets

- Be aware of the particular challenges and hazards of surgery for cervico–thoracic deformity in Ankylosing Spondylitis,
- Recognise the peri-operative preparations and precautions required in surgery for cervico–thoracic deformity in Ankylosing Spondylitis,
- Understand the surgical technique described.

Introduction

Ankylosing Spondylitis (AS) is a chronic inflammatory seronegative rheumatic arthritis [1]. It affects the axial skeleton, predominantly at sites of ligament insertion into bone, and the aetiology is not fully understood [2, 3]. Typically, this processes first affects the sacroiliac joints, later progressing to involve the hips and spine [4].

The result is a characteristic sagittal plane deformity, sometimes described as the “Question Mark” posture due

to the appearance when viewed from the side. In order to maintain forward gaze, the patient flexes the knees, tilting the trunk backwards.

Surgery to correct the kyphotic deformity in AS can be associated with serious risks [5]. In 1945 a technique using multiple extension osteotomies in the lumbar spine of rheumatoid arthritis sufferers was described by Smith-Peterson et al. [6]. Subsequently, many authors have published on a variety of surgical strategies for addressing the kyphosis in AS [7–16]. Cervical osteotomy in these patients remains challenging because of the high risk of neurovascular compromise.

A case report from 1958 describes a significant correction of deformity in AS, using a cervical osteotomy technique [17]. Later in 1977, a case series of 42 AS patients treated successfully with cervical osteotomy under local anaesthetic was published by Simmons [18]. That technique had previously been described under general anaesthesia in 1959 [19]. In 1997, a case-series of cervical osteotomies under GA with patients in a prone position was reported by McMaster [20]. Since then, there have been a number of reports by surgeons using the same surgical technique but under local or general anaesthetic with Halo immobilisation or internal fixation [21–25]. In 2006, a 36 years experience, incorporating 131 cases, using local anaesthesia and Halo immobilization was published by Simmons et al. [26]. We first published our technique for a safe and controlled reduction of the osteotomy in this journal in 1999 [27] and updated the technique with improvements in 2008 [28]. It is this latter technique, which was utilized in the current case.

Electronic supplementary material The online version of this article (doi:10.1007/s00586-012-2587-2) contains supplementary material, which is available to authorized users.

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A patient with symptomatic cervical deformity secondary to (AS) was referred to our centre for treatment. In order to address the primary site of deformity, a C7/T1 osteotomy was planned. We describe the procedure, utilizing a technique, which minimizes the risks of neurological injury, which allows full correction of the deformity and restore normal chin-brow to vertical angle (CBVA).

Case description

A 38-years-old male patient with Ankylosing Spondylitis (AS) presented with severe, progressive cervico-thoracic kyphotic deformity (CTKD). He complained of loss of horizontal gaze, incidents of choking and poor self-image. Treatment options were discussed at length, including the attendant risks. The primary deformity was at cervico-thoracic region, so a C7/T1 cervical osteotomy was the recommended treatment, provided pre-operative investigations and specialist anaesthetic review confirmed his suitability for the surgery. The patient's hips and lumbar spine were less severely involved in the disease process; otherwise these areas would have taken priority for hip replacement or lumbar osteotomy respectively.

Preoperative plain radiographs (Fig. 1) were used to quantify sagittal parameters (Table 1). In addition to whole spine radiographs, and lateral profile of the skull was obtained to include the head and cervico-thoracic region. This was used to derive the CBVA value of 55°. The CBVA was used to estimate the osteotomy angle required (Fig. 2).

The patient underwent Computed Tomography Scan (CT), confirming extensive intervertebral and posterior element ankylosis but confirmed normal dimensions of the vertebral canal at the proposed osteotomy site and normal foramina. The ankylosis included the costo-transverse, costo-vertebral and sterno-costal regions. This finding suggests little or no chest wall movement and reliance on diaphragmatic breathing. The CT confirmed ankylosis of the occipito-cervical junction, excluding instability in this region. Importantly, no fractures were seen. Three dimensional reconstructions were produced to aid in preoperative planning and assist estimation of the anticipated track of lateral mass screws.

Magnetic Resonance Imaging (MRI) of the spine confirmed a reasonably sized canal with no abnormalities of the spinal cord.

Magnetic Resonance Angiogram (MRA) clarified the anatomy and patency of the vascular structures. The vertebral arteries were normal.

Lung Function tests/Spirometry were 70 % of predicted value.

Preoperative neurophysiological assessment revealed normal upper limb studies but Somatosensory Evoked Potentials (SEPs) were borderline delayed-for-height following stimulation of either tibial nerve at the ankle.

Venous blood samples were obtained for routine chemistry, blood count and typing.

An assessment by an experienced anaesthetist was performed: anticipating a difficult airway is routine in these patients and limited chest expansion can have implications for post-op ventilation and weaning. Awake, fibre-optic

Fig. 1 Sagittal lumbar and cervico-thoracic T2W MRI scans

Table 1 Pre- and post-op sagittal radiographic parameters

Radiographic parameter (derived from whole spine lateral scoliosis films)	Pre-op	Immediate post-op
Chin-brow to vertical	55°	3.3°
T4–T12	59.2°	56.2°
C6–T12	92.4°	58.3°
C7 plumbline to back of S1 (SVA)	+96.6 mm	+50.1 mm
C2 plumbline to back of S1	+191 mm	+80.4 mm
Lumbar lordosis	37.4°	43.2°
Pelvic tilt	28.6°	31.5°
Pelvic incidence	55.6°	54.6°
Sacral slope	26.8°	25.3°

Fig. 2 Pre-op whole skull and cervico-thoracic plain lateral radiograph

intubation was planned, with an experienced Maxillofacial surgeon available should a surgical airway be required itself a challenge in this type of deformity.

Surgical procedure

Prior to the procedure the operating table and bolsters were adjusted to accommodate the patient's deformity. A team briefing ensured all members of the theatre team plus equipment were prepared. A trial osteotomy-closure manoeuvre was rehearsed, to ensure the range of adjustment available on the head support was adequate and that each member of the team was familiar with their role.

The procedure was performed under general anaesthetic after an awake, fibre-optic endotracheal intubation. Spinal

cord-monitoring electrodes were placed to allow cord monitoring using both somato-sensory and motor-evoked potentials. Antibiotic prophylaxis, intraoperative warming and mechanical thromboprophylaxis measures were utilized.

A Halo ring was placed in the conventional manner. The patient was position prone with the head resting on a padded horseshoe frame, avoiding direct pressure on eyes and face. The hair of the occiput was shaved-off and removed. After marking and prepping the skin a translucent self-adhesive drape (the type usually used for Compression Hip Screw procedures) was applied. Care has to be taken that the drape is not pierced by the corners or pins of the Halo. A translucent drape is important as it allows assessment of the position of the head during the correction manoeuvre and simplifies adjustment of the head support and horseshoe frame thereafter. The marked incision site was infiltrated with norepinephrine to reduce bleeding.

After a brief interval to allow baseline neurophysiology readings, the spine was approached via a posterior, midline incision extending from C1 to T7. It is imperative that the incision be carried far enough distal to prevent soft tissues impinging on the temporary instrumentation (malleable rods) during osteotomy closure. The cervical and upper thoracic spine was exposed from C2 to T6. It is common to encounter more bleeding during the approach and from the bone than would be expected in a non-inflammatory condition. Bone wax was used where necessary to facilitate a bloodless field.

A plain, lateral radiograph was obtained to confirm levels. Tracks for pedicle screws were prepared using a freehand technique bilaterally from T1 to T5. The lateral masses from C3 to C6 were drilled using a stop-drill set to 14 mm with fluoroscopic imaging to guide angle and entry point. 3.5 × 14 mm poly-axial screws of the Axon system (Synthes) were used in the lateral masses, 4 mm poly-axial screws in T1 to T5.

In order to prevent binding of the malleable rods as they glide through the thoracic screws during the reduction manoeuvre these thoracic screws were aligned with the C6 screws using a temporary hard rod and the screws converted to mono-axial mode by tightening a nut down onto the rod (this is a feature of the Axon system.) This done, the nuts and rods were removed on each side.

The osteotomy was mapped onto the bone using pen. The area defined was the whole of the C7 lamina, the bottom of C6 and top of T1 lamina. This bone was carefully removed and the resection carried laterally, allowing identification and decompression of the C8 nerve roots. The pedicles of T1 and C7 were also partially excised to prevent compression of the C8 roots after closure of the osteotomy.

Temporary, malleable rods were then firmly fixed into the screws in the cervical region, but only very loosely

contained in the screws of the thoracic region. It is imperative that the rods are free to slide through the thoracic screws, yet be unable to escape from the screw. The rods used are the sterilized, metallic core of a 3.5 mm intubation stylet or bougie (size WW Make Pty). A surplus length of each rod was left emerging from the most distal screw on each side; these rod ends were grasped with Kocher's to provide grip, allowing the assistant to apply

traction. The surgeon then held the Halo on each side of the head and closed the osteotomy by lifting the head while the assistant simultaneously pulled on the distal ends of the malleable rods. An unscrubbed surgeon, observing from the lateral aspect, guided the operating surgeon to avoid over- or under-correction. The head support and horseshoe frame were adjusted to provide safe support for the new position. Before the releasing the head, the malleable rods were fixed to the thoracic screws bilaterally, as a holding measure while definitive rods were prepared.

At this point, the neurophysiology team reported a 50 % reduction in potentials from the left arm. An exploration and decompression of the C8 nerve root on the left was performed.

The definitive 3.5 mm titanium alloy rods were contoured and fixed in place of the temporary rods; at all times at least one rod was in situ. Final tightening was performed. Bone surfaces were decorticated and covered with morcellised autograft. The osteotomy site was covered by Haemaccel.

The incision was closed in layers over two deep suction drains. The wound was dressed and an Aspen collar applied.

Postoperative information

The patient was transferred to intensive care for the first postoperative night as a precautionary measure. The Halo ring was left in situ, in anticipation of fitment of a Halo jacket and frame before discharge.

The patient made an excellent recovery following surgery. He was delighted with the correction, which equated to a new CBVA of 3.3° (Figs. 3, 4). A Halo jacket was applied once the wound was dry and the patient could sit comfortably for fitment. Neurological examination

Fig. 3 Post-op whole skull and cervico-thoracic plain lateral radiograph

Fig. 4 Pre- and post-op photographs of the patient

revealed a reduction in power of the left C7 myotome to grade III (MRC) and dysaesthesia in a C8 distribution bilaterally. By 6 weeks the neurological examination was normal. Routine Halo care and adjustment was arranged and the patient was discharged. The Halo was removed 3 months from surgery. The patient remains delighted with the outcome.

Conflict of interest None.

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