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Atlantoaxial instability treated with transarticular screw fixation

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Abstract We treated 11 patients with atlantoaxial instability using transarticular posterior screw fixation and lateral bone grafting. A posterior bone graft was added in eight patients. The results showed good reduction and a stable fixation. After 6 months ten patients had regained almost 70% of rotation and did not notice any significant limitation.

Résumé Nous avons traité 11 patients pour instabilité atlo-axo utilisant une fixation par vis transarticulaire postérieure avec greffe osseuse latérale. Une greffe postérieure a été ajoutée chez huit patients. Les résultats ont montré bonne réduction et une fixation stable. Après 6 mois dix patients avaient regagné presque 70% de la rotation et ne se plaignaient pas de limitation notable.

Introduction

The main pillar of stability of the atlantoaxial joint is the odontoid process and among the associated ligamentous complex there is the transverse atlantal ligament [7, 10, 12]. Therefore the integrity of both these structures is critical and even if bone healing of the odontoid occurs the atlantoaxial stability will not be restored if the transverse ligament is damaged [5, 16]. These are potentially serious injuries [3].

Elderly patients have received particular attention in regard to odontoid fractures, and they are considered to be more likely to suffer non-union than younger patients, even though the injury is usually due to low velocity

trauma in this older age group [8, 18]. According to Anderson and D'Alonzo's [1] classification of odontoid fractures which was used in our study, their type II and type III can result in instability of the atlantoaxial joint.

Fusion of the atlantoaxial joint is often indicated in the following pathological conditions: trauma with pure ligamentous damage or a dens fracture, inflammatory arthritis, rotary subluxation, os odontoideum and skeletal dysplasia with C1–2 instability.

The options available for treatment range from conservative management with a long-term immobilisation in a halo vest or cervical collar [15] to various surgical procedures. The different operative techniques available to treat atlantoaxial instabilities include anterior odontoid screw fixation for odontoid fractures [6], posterior wiring techniques described by Gallie [9, 15], Brooks and Jenkins [2] and their modifications, posterior Hali-fax clamps [11] and the relatively new posterior transarticular screw fixation [17].

In view of the considerable risk of non-union of odontoid fractures in elderly patients [8, 18] and their frequent intolerance of long-term neck immobilisation, it is important to use a method for treatment which is both stable and allows early mobilisation without any need for external splintage.

Materials and methods

Eleven patients treated with transarticular screw fixation for atlantoaxial instability in the Orthopaedic Department of the Victoria Hospital were included in our study. All patients treated by other methods or who had instability at other levels in their neck or spine were excluded. Information regarding the patients' age, sex and the cause of the instability is given in Table 1.

Seven patients with an odontoid fracture or a transverse ligament rupture gave a definite history of trauma. Amongst these four were involved in motor vehicle accidents (and three suffered polytrauma), one, a cyclist, had a collision with a truck, another had a fall from a bicycle, and one had fallen down stairs. Two patients with an os odontoideum and odontoid hypoplasia believed that sports injuries were responsible for their symptoms whereas two patients with instability due to rheumatoid arthritis and os odontoideum had no definite history of trauma.

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Table 1 Summary of materials and methods

Case	Age Sex	Cause of instability	History of significant trauma	Delay between symptoms onset to surgery	Supplementary surgical procedure
1	79 F	Trans ligament rupture	Yes	5 days	Posterior wiring and bone graft
2	62 M	Type II odontoid fracture	Yes	2 weeks	Posterior wiring and bone graft
3	71 F	Type III odontoid fracture	Yes	6 days	Posterior Marsiline tape and bone graft
4	31 M	Trans ligament rupture	Yes	2.5 months	Posterior wiring and bone graft
5	26 M	Type II odontoid fracture	Yes	4 months	Posterior wiring and bone graft
6	26 M	Trans ligament rupture	Yes	8 months	Posterior braided polyethylene suturing and bone graft
7	29 M	Type II odontoid fracture	Yes	3.5 months	Posterior wiring and bone graft
8	24 M	Os odontoideum	No	7 months	Posterior wiring and bone graft
9	65 M	Rheumatoid arthritis	No	2 weeks	None
10	21 M	Os odontoideum	No	15 months	None
11	14 M	Odontoid hypoplasia	No	4 months	None

Fig. 1 Anteroposterior view after transarticular screw fixation and posterior wiring to hold graft **Fig. 2** Lateral view of a 62-year-old man with type II odontoid fixation 2 months after surgery

The most frequent symptoms in these patients were pain, discomfort, stiffness and restriction of neck movements, particularly rotation, and transient numbness in their upper limbs. Four patients underwent surgery within 2 weeks from the onset of symptoms whereas seven patients had been treated non-operatively for 2.5 to 15 months before undergoing surgery.

The surgical technique used in the present study was similar to that described by Magerl and Seemann [17] and always included using cannulated screws and performing lateral bone grafting (Figs. 1, 2). Any additional surgical procedures are mentioned in Table 1. At the end of the procedure the traction device (halo or tongs) was removed and the patient was fitted with a simple Philadelphia collar.

Results

Postoperative radiological examination showed good reduction and a stable fixation in all our patients. Stability of the transarticular screw fixation was also evident since these patients required no head support when discharged from hospital. They all remained neurologically intact and four who had complained of transient paresthesia recovered after operation. None of the patients had any significant pain or discomfort 2 months after surgery. One developed infection postoperatively and this was treated successfully by debridement without any loss of stability. One patient developed a husky voice after surgery.

If 80° is considered to be the normal range of rotation to either side, then ten of our patients regained 50% of neck rotation 2 months after operation, seven after 4 months and ten noticed no significant limitation of rotation and had regained almost 70% of rotation after 6 months. Only one patient whose instability was due to rheumatoid arthritis was limited to 40% of rotation after 4 months but, unlike the others, his preoperative neck movements had already been restricted by rheumatoid disease.

Radiological examination at 4 months after surgery revealed that all the patients had a good stable reduction with signs of consolidation and all had fused by 6 months. Using the criteria of Conaty and Mongan [4] all patients showed satisfactory improvement. No patient had an unsatisfactory result (i.e. pain remained unchanged, lack of improvement of neurological symptoms and lack of calcification of fusion mass).

Discussion

Each of the various techniques available to treat atlantoaxial instabilities whether anterior or posterior have certain limitations. Anterior odontoid screw fixation [6] has been used in the treatment of odontoid fractures and this technique has the theoretical advantage of leaving the motion segment of C1–2 intact, thus preserving some rotation at the atlantoaxial joint. However, only the study of Jeanneret et al. [14] records the actual range of rotational movement, which was preserved by this technique. In their study they reported that atlantoaxial rota-

tion at follow-up averaged 25° in each direction. Therefore the theoretical advantage of this method does not occur in practice. In addition, the screw is most likely to cut out where there is insufficient density of bone. In many patients there may not be adequate room for two screws and the insertion of a single screw may produce rotation of the fracture fragment.

Posterior wiring of the atlas to the axis has also been widely used and the most common procedures are those described by Gallie [9], Brooks and Jenkins [2] and their modifications. The use of this technique is limited when there is an absent or insufficient posterior arch of C1 [11]. The stability of this technique is also doubtful since the biomechanical studies done by Montesano et al. [19] and other authors [11, 13] show marked anteroposterior displacement. The use of two Halifax clamps [20] may be slightly superior to wiring, but both of these procedures cannot be performed in case of fracture or of absence of the posterior arch of the atlas.

The comparatively new technique of atlantoaxial transarticular screw fixation used in the present study has been biomechanically tested by Montesano et al. [19] and Grob et al. [11]. It has been found to be significantly 'stiffer' in rotation than the Gallie technique and no displacement in the anteroposterior plane was observed, whereas this displacement was noted with the posterior wiring technique. Thus studies done by both these authors prove the reliability of the multidirectional stability of this technique. Contrary to other traditional posterior fusion techniques the integrity of the ring of C1 is not necessary and thus this technique can be used even in cases of fracture or absence of the posterior arch of atlas.

Thus transarticular screw fixation provides one of the most stable forms of fixation for fusion of the atlantoaxial joint in all kinds of pathologies and is therefore recommended as the method of choice for treating instability of this joint especially in elderly patients who do not tolerate external immobilisation.

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