Trans-Articular C1-C2 Fixation: Results Of Twenty-Nine Patients

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Citation

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Abstract

Twenty –nine patients having atlanto-axial instability were treated by trans-articular C1-C2 screw fixation .there were twenty one male and female patients with average age of 40.7 years(range, 16 - 56). There were eighteen cases of ligamentous atlanto-axial instability, five cases of C2 fracture, five patients with odontoid fracture and a case of non-union of odontoid. Patients were operated between 1-2 weeks of hospitalization. The follow-up averaged 43 months (range 24-60). Fusion occurred in 90% of the patients with good results in 86 % patients. Screw malpostioning, vertebral artery injury, and guide wire breakage were the complications observed during the study.This study establishes the efficacy of trans-articular screw fixation in these highly unstable injuries of cervical spine.

INTRODUCTION

Disruption of bony or ligamentous structures of the atlantoaxial(C1-C2) complex can lead to life threatening instability[1].Stabilization of atlantoaxial complex is required to prevent further displacement, neurological compromise and to decrease pain.

Posterior stabilization of C1-2 is indicated for a number of conditions causing instability of C1-C2(traumatic, degenerative , inflammatory and congenital)[2].Unique architecture of atlantoaxial complex and its proximity to vital structures poses challenges to its stabilization[3].For achieving stability a number of surgical procedures are described (sub laminar wiring, posterior bone grafting, interspinous wiring and interlaminar clamp application), however all of these have high complication rates[2,3,4,5,6].Trans-articular screw fixation first described by Magrel in 1986 has got good acceptance as it achieves higher rates of fusion because of superior biomechanical stability and rigid fixation [3,5,7,8,9,10]. The present study describes the results of this method in our institution.

MATERIAL AND METHODS

Between 2002 and 2005, C1-C2 trans-articular fixation carried out in 29 adult patients with atlanto axial instability at this hospital. All the patients were operated upon by the senior author [RB]. Patients were subjected to physical and radiological examination at the time of admission. Patients with Atlanto Dense interval of more than 5 mm on lateral flexion radiograph, fracture of odontoid, and fracture of C2 vertebra was considered for transarticular fixation. The patients which had listhesis of C2 over C3 additional procedure of anterior C2-C3 discectomy ,bone grafting and stablisation with H plate was done. Patients with traumatic instability were kept in skeletal traction till they were operated upon, whereas those patients with non traumatic instability were immobilized in a Philadelphia collar.

OPERATIVE TECHNIQUE

After endotracheal intubation patients were turned to prone position with skeletal traction maintained by crutch field tongs. Some flexion was maintained at neck to negotiate guide wires and screws. Area of posterior iliac crest was also prepared to harvest the bone graft. Through posterior midline approach C1-C2 complex was exposed and C1-C2 joint capsule was removed from posterior surface.

The insertion point of the guide wire was the most inferior aspect of C2 lamina,2-3 mm lateral to medial border of C2 pedicle. Under image intensifier control guide wire was advanced directed towards superior margins of arch of C1 directing it slightly in lateral direction. The desired length was measured and a 4 mm partially threaded cancellous screw was advanced over the guide wire after drilling and tapping under image intensifier control. Bone graft was placed at decorticated facet joints and interlaminar space and the wound was closed. While performing the procedure it

was ensured that head did not rotate to either side. Postoperatively neck was immobilized in Philadelphia collar. Sitting with collar and ambulation was permitted as and when patient was comfortable.

After suture removal the patients were discharged and followed at regular intervals for decrease in pain, radiological union, change in neurological status and any complications. Patients were followed at four weeks till signs of radiological union and at six months thereafter.

RESULTS

Of the 29 patients, there were twenty-one males and eight females, with an average age of 40.7 years (range, 16-56) and the average follow-up was 43 months [range 24-60 months].The patients pattern for surgery is depicted in table I.A master chart describes the patient profile in table II. The results were graded as good, fair and poor as per the following criteria-

Good-No neck pain, good bony fusion, unrestricted activities

Fair- Mild to moderate neck pain, bony fusion, activities of less than one hour

Poor- Severe neck pain, no fusion and marked limitation of daily activities

Out of five patients with fracture axis, four had anterior translation of C2 over C3 and in these patients anterior stabilization with bone grafting was done as second procedure. One patient had fracture C6 with quadriparesis. In this patient subsequent anterior decompression and H plating was done anteriorly.

Patients were operated between 1-2 weeks (average10 days) of hospitalization .Fifty-seven screws could be negotiated in 29 patients; second screw could not be negotiated in one patient. In two patients there was suspected insult to vertebral artery on one side and the bleeding responded to application of pressure. No deterioration of neurological status occurred in those patients. There was one instance of breakage of guide wire, while it was being pulled out after screw placement.

Seven patients had neurodeficit-one patient with right sided monoparesis and six patients had quadriparesis. Four patients had complete neurological recovery, in two patients there was an improvement of one grade and in the last patient with neurological deficit no recovery in his neurological status had occurred after 36 months of follow-up.

There was no implant failure or worsening of neurological status following trans-articular C1-C2 fixation. We did not come across any case of infection or non union; however there was one instance of screw backing out necessitating prolonged immobilization for 20 weeks eventually resulting in posterior fusion.

All patients reported restriction of rotational movements of neck, though they did not complain of any handicap because of this. Patients with rheumatoid arthritis have restricted activities secondary to involvement of of other joints. On grading results, twenty-five patients have good results and four patients have fair results. The patients with fair results have mild to moderate pain over the neck, however there is radiological evidence of fusion in one case and the fusion was doubtful in remaining three cases.

DISCUSSION

Trans-articular screw fixation of C1-C2 is considered to be one of the most rigid atlantoaxial posterior stabilization techniques [11,12]. C1-C2 being close to brain stem, instability at this level has inherent danger of causing serious neurological complications. Gallie introduced the C1-C2 interspinous fusion with an iliac crest bone wire construct, which was modified later by Brook and Jenkins[13].Brooks technique provides immediate stability [2] , but the passage of wires under lamina of C-2 can produce irreversible and devastating spinal cord injury [6 ,14,15].Moreover these procedures did not provided rotational stability, and were associated with high incidence of non union and implant failures. The requirement for postoperative rigid immobilization (Halo, Minerva) for union also increased the complications-pin tract infections ,skin breakdown and complication of recumbency [16].Fusion rate by posterior wiring techniques has been reported to be between 50-80% in the literature, the failure being attributed to abnormal mobility , poor bone stock and unstable fixation [4,5,17].

Fusion rate in this study rate was 90% and this is the advantage of posterior trans-articular C1-C2 screw fixation over other methods. Biomechanically, C1-C2 fixation is more rigid than wiring techniques or Helifex clamp fixation as it provides immediate rotational and translational stability and thus gives higher fusion rates [5,16]. Various authors have reported similar fusion rates of 95-100% with posterior screw fixation [18, 19]. Trans-articular screw fixation is nearly 10 times stiffer in rotation than posterior wiring and has more resistance to shear stresses [8]. The pronounced

rotational instability caused failure of fusion in posterior wiring techniques. Trans-articular screw fixation is suitable for all kinds of C1-C2 instabilities e.g traumatic transverse ligamentous injury, fracture odontoid, rheumatoid arthritis, ligamentous laxities and congenital malformations.

The screw malpositioning in this study is 8 %. The incidence of screw malposition has been reported between 10-15% in various studies [7, 10]. Complications with screw malpositioning is low. We did not have any complication with screw malpositioning, though malpositioned screw can pose danger to vertebral artery, spinal cord and raise risk of non-union. We suspected injury to one vertebral artery in two patients (7%), in both of these cases bleeding stopped by application of pressure. No deterioration of neurological structures occurred in these patients. The risk of neurological injury as a result of single vertebral artery injury is very low. Vertebral artery injury is a dangerous complication , which is bound to occur as vertebral artery has anomalous path in approximately 10% of normal population and altered anatomy further predisposes it to injury [3].Pre-operative CT angiography is advisable wherever the facilities are available but we had no such facility at our institution and could not do this investigation before surgery. Madavii et al has reported five cases involving vertebral artery out of 61 patients who underwent trans-articular screw fixation. Injury to vertebral artery can be avoided if the placement of guidewire as well as screw is continuously monitored under image and is ensured that guide wire as well as screw remain within the bony architecture in both the AP and the lateral view.

Other reported complications are dural tears, hypoglossal nerve palsy, suboccipital neuralgia and implant failure [3,12], no such complications were observed in this series. Anatomy of the occipito-cervical region makes correct insertion of screw technically difficult and proper positioning of the patient is important. It is very essential to have position, which gives proper images in anteroposterior and lateral views, any compromise can result in screw malpositioning. Cannulated screws have advantages of navigation on non-canulated screw. Canulated screws allow greater flexibility and improves ability to reposition the screw, as guide wire provides path for screw insertion, fixes and prevents displacement while drilling and inserting screw. Thin guide wires allows trajectory to be repositioned without causing loss of bone.[20].

In all patients there is some loss of rotational movement of neck as approximately 50% of neck rotation is contributed by this joint. The patients have not complained of any handicap because of loss of rotation so far. This procedure requires high surgical precision to avoid injury to spinal cord and vertebral arteries.

The aim of surgery in these cases is to stabilize the unstable segment so that further displacement does not occur. Complete reduction is difficult, as it requires extension of neck, which causes difficulty in inserting the screws. The reduction becomes more difficult in patients who report late, even after traumatic atlanto-axial subluxations, to the hospital because of delayed diagnosis and poor referral system in rural healthcare. The lack of modern diagnostic modalities and poor financial background of most patients also contributes to delayed or improper diagnosis of these injuries. As these procedures are technically demanding, the inadequacy of trained manpower further adds to the delay in fixation of these highly unstable injuries.

CONCLUSION

Posterior trans-articular C1-C2 screw fixation is more rigid than all wiring and laminar clamp techniques [10, 11, 21, and 22]. This method of fixation resists rotational forces that could be responsible for fusion failures in other constructs. Immediate atlantoaxial stability is achieved, obviating the need for rigid external bracing. Posterior TAS fixation can be used successfully in atlanto axial instability, fracture of C2, fracture and nonunion of odontoid, failed odontoid fixations and in circumstances where C1 arch is deficient. However proximity to vertebral artery, spinal cord and altered anatomy makes it a technically demanding procedure.

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