Original Article

Posterior Atlanto-Axial Stabilization using Laminar Hooks: Experience of 20 Cases

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ARTICLE INFO

ABSTRACT

Background: Trauma is a common cause of C1-C2 instability. Treatment of atlantoaxial instability is aimed at stabilization, bony fusion, improvement of neurological status and restoration of normal anatomy. Various surgical techniques were described including: Transarticular and transpedicular screws, laminar hooks, and sublaminar wiring.

Objective: Determining the outcome of C1-C2 fixation with posterior laminar hook system for treatment of C1-C2 instability, concerning the clinical picture and rate of fusion.

Patients & Methods: Twenty patients assigned for C1-C2 fusion for non-neoplastic causes were included. Patients were assessed clinically and radiologically before and on second day after surgery. Patients were followed up for a period of 6 months. All patients were operated upon by posterior laminar hooks with bony grafting.

Results: Postoperative imaging showed proper reduction and alignment in all cases. In the last follow up, there was evidence of bone fusion in thirteen cases (65%), while the rest of cases showed proper hook positions with no movement on dynamic images.

Postoperative clinical evaluation revealed significant improvement of neurologic ASIA grading in 90% of cases, while two patients (10%) had persistent upper limb weakness.

Conclusion: Posterior C1-C2 fixation using sublaminar clamps is a technically simple technique with high success rates of fusion and clinical improvement. The main disadvantage of this technique is the need for intact posterior bony elements.

INTRODUCTION

The incidence of serious cervical spine injuries is low but associated rates of death and disability are high. Hyperflexion is the most frequent mechanism of injury. Odontoid fractures represent 9% to 15% of all cervical spine fractures in adults. Injuries of the transverse atlantal ligament, alar ligament and cruciate ligament usually accompany odontoid fracture. Anterior and posterior slips following odontoid fracture and ligament injury may cause spinal cord compression. The treatment for atlantoaxial instability is predominantly surgical, aimed at stabilization, bony union, improvement of pain and neurological status and restoration of normal anatomy of atlantoaxial joint. Transarticular and transpedicular screws fixation are widely used in stabilizing the cervical column. In spite of the benefits of transpedicular screw fixation, controversy still exists regarding its potential risks. Incorrect insertion of pedicle screws can cause damage to adjacent vital structures such as the spinal cord, nerve roots, cranial nerves, and vertebral arteries. The laminar clamps, sublaminar, or interspinous wiring can be used as alternatives to posterior screw fixation. Biomechanical experiments showed that these techniques can provide excellent anteroposterior stability. However, the rotational movement has been less successful. These techniques still have nonunion rates varying from 3% to 25%. Laminar hook systems, such as Halifax clamps (Apofix, SofamorDaneek), avoid the passage of sublaminar wires, reducing the potential risks of spinal cord injury from introduction of the wires and also do not have the risks of wire breakage or pull-out.

PATIENTS AND METHODS

The present prospective study was conducted at the Department of Neurosurgery, Cairo University with 6 months follow up period for the last case operated upon. The study included twenty patients, who were indicated for C1-C2 fusion for fracture odontoid, transverse atlantal ligament injury, os odontoideum or rheumatoid C1-C2 instability. All patients were above 12 years of age. They were fully conscious and had radiological evidence of C1-C2 instability. Each patient was evaluated clinically and radiologically with X-rays of the cervical spine in lateral projection and anteroposterior projection or CT. The diagnosis was
verified by MRI for all patients. Patients were managed first by reduction (if needed) and then posterior C1-C2 fixation with laminar hooks and bony graft. Plain x-ray was done immediate postoperative and after 6 months. In some cases CT was also done for better visualization of fracture. Patients were followed up for evaluation of successful bone fusion, non-union or loosening of the hooks. Outcome measures included radiological evaluation of successful fusion of the bone graft to the posterior elements of the spine (absence of motion in dynamic views and evidence of trabecular bone formation linking the adjacent spinal elements), neurological evaluation using the American Spinal Injury Association (ASIA) motor score, neck and arm VAS pain scoring, neck disability index (NDI) and the functional independence measure (FIM) presented as total motor score.

Surgical technique: Patients were positioned prone; traction was used when needed to restore anatomic alignment. In cases where traction was not done, the head was fixed with three-pin fixation. Exposure of the posterior upper cervical spine and the craniocervical junction was then accomplished in the usual manner. The posterior elements of C1 and C2 were cleared off from all soft tissues at least 15mm to each side of the midline. The upper hooks were inserted, then after dissection of the ligamentum flavum from the lamina, the caudal hooks were inserted and the rod was applied. Iliac crest bone graft was placed between C1 and C2 laminae and secured in place using non-absorbable sutures. Patients were advised to wear a Philadelphia neck collar for 4-6 weeks postoperatively. (Fig 1)

RESULTS

The age of the patients ranged between 13 and 55 years with a mean age of 34.4 years ± SD 12.11. The highest percentage of cases was in the 4th decade (40%). We had thirteen males and seven females, with a male to female ratio of 1.85:1. Despite of the male predominance, there was no significant difference in prognosis between both sexes. The cause of instability was fracture odontoid process in eleven cases (55%), injury to the transverse atlantal ligament in four cases (20%), os odontoideum in three cases (15%), and rheumatoid C1 –C2 instability in two cases (10%). The mean duration of symptoms was 2 days; ranging from 3 hours (traumatic cases) to 4 months (rheumatoid). Preoperative neurological evaluation showed that all patients complained of posterior cervical pain with variable degrees of radiation to the occipital region. The mean preoperative neck and arm VAS pain scale score was 6.8 ± 1.19 SD, mean preoperative neck disability index scores was 37.55 ± 8.99 SD. Six patients were classified as ASIA grade B (30%), five patients were ASIA grade C (25%), seven patients were ASIA grade D (35%), and two patients (10%) were ASIA grade E.

All surgeries were conducted smoothly without intraoperative complications. The mean duration of the procedure was 100 min (range 80–150 min) and the average blood loss was 300 ml. There were no spinal cord injuries due to hook placement under the lamina. No vascular or neurological complications were encountered.

Postoperative imaging showed proper reduction and alignment, there was evidence of bone fusion in thirteen cases (65%), the seven remaining cases showed proper hooks positions and no movement on dynamic films as in (fig 2). Three cases showed oblique position of the hooks on one side relatively to the opposite side with no affection on reduction or alignment. Postoperative clinical evaluation revealed significant improvement of neurological ASIA grading, five patients (25 %) showed complete recovery without motor or sensory deficit (ASIA grade E), seven patients (35%) had ASIA grade D, six patients (30%) ASIA grade C, while two patients (10%) had ASIA grade B with persistent upper limb weakness and exaggerated reflexes (fig 3 and 4). Neck and arm pain (VAS scale) showed significant decrease during the follow up period (2.75± 2.34 SD) compared to preoperative scores (6.8 ± 1.19 SD), Neck disability index (NDI) showed significant decrease after 6 months (23.6 ± 12.21 SD) compared to preoperative scores (37.55 ± 8.99SD). Postoperative total FIM motor power scoring (57.6) was significantly higher compared to preoperative measures (26.8) and remained as such during the follow up period. (Table 1)
Table (1): Postoperative neurological and functional scores recorded at the end of follow-up period compared to preoperative scores

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<td><strong>VAS pain score</strong></td>
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<td><strong>NDI score</strong></td>
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<td><strong>FMI score</strong></td>
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Fig. 2: a: Axial CT scan, and b: Sagittal MRI of 13 yrs. old male patient with history of fall from height showing fracture odontoid type II. c,d: postoperative dynamic x-rays showing good alignment and absence of instability. The ASIA score improved from grade D to grade E.

Fig. 3: a,b: Pre and c,d: postoperative CT scan of a 51 yrs. Old male with traumatic fracture odontoid. Postoperative images show adequate reduction, proper placement of hooks. Patient ASIA score improved from grade B to grade D during 6 months follow up.

Fig. 4a-c: a: Preoperative MRI of a 21 yrs. Old female with post traumatic type II fracture odontoid. b,d: Postoperative CT scan after 6 months, showing good reduction. ASIA score improved from Grade C to grade D.

**DISCUSSION**

Traumatic Atlanto-Axial instability is a common type of injury; it includes fracture or dislocation of the spine, as well as ligamentous injury. Therapeutic options include decompression of the neural elements as well as restoring the normal anatomical alignment of the spine via stabilization and fusion. The present study included twenty patients with C1-C2 instability attributed to varied causes, mostly 55% due to
odontoid fracture, transverse atlantal ligament injury in 20%, os odontoideum 15%, and rheumatoid C1–C2 instability 10%. Such figure for the frequency of odontoid fracture goes with Lomoschitz et al. who described the patterns of atlantoaxial fractures in a population of consecutive patients and found a large proportion of these patients (74%) had odontoid fractures. The mean age of cases in our study was 34.4 years. Our results and also review of literature, suggest that no age is exempt from this problem.

All cases had no new neurological manifestations, or loosening of the clamp. However only thirteen cases (65%) showed evidence of fusion in the last follow up images, while the remaining seven cases are reduced, stable in the dynamic views and need further follow up for better assessment of fusion. Some authors have contended that conventional radiographs may underestimate the degree of fusion. The reason for this is believed to be that premineralized osteoid may be functionally fused but may nevertheless appear radiolucent on conventional radiographs. The calcification of osteoid typically takes many months to complete. As a general rule, it is accepted that at least 6 to 9 months from the time of surgery are necessary for the development of solid inter-segmental fusion to be seen radiographically.

These results were superior to that reported in earlier studies; Statham et al., reported that complications occurred in 14 of 45 patients undergoing atlantoaxial arthrodesis and additional operations to achieve bone fusion were required in nine patients (20%)11. The obtained results in this series were less than that obtained with Huang & Chen who reported solid atlantoaxial arthrodesis in all (100%) of their thirty two patients.

There was significant improvement of neurological ASIA grading in 90% of cases, and seven cases (35%) showed complete recovery without motor or sensory deficit. Pain and the neck disability scores showed significant decrease postoperatively compared to preoperative scores with significantly higher postoperative total FMI motor power scoring compared to preoperative measures. These data goes in hand with the development of solid inter-segmental fusion to be seen radiographically.

This technique has two major drawbacks. The first is the need for intact posterior bony elements and thus decompression of the cervical spine by posterior laminectomy cannot be done. The second drawback is less biomechanical strength of posterior laminar hooks. The posterior laminar hooks are two point fixation which is by all means having lower biomechanical strength than the three point fixation offered by other methods, such as transarticular screws combined with Gallie. In this study this was overcome by using Philadelphia neck collar for 3 months in the postoperative period.

CONCLUSION

Posterior C1-C2 fixation using sublaminar clamps is a technically simple technique; it can be done safely without intra- or postoperative complications. High success rates of fusion and clinical improvement made this technique a good surgical modality for higher cervical spine instability. The main disadvantage of this technique is the need for intact posterior bony elements.

REFERENCES