Turkish Neurosurgery 2009, Vol: 19, No: 4, 345-348

Original Investigation

Bilateral C1-C2 Claw for Atlantoaxial Instability

Atlantoaksiyel İnstabilite için C1-C2 Pençe Uygulaması

Hakan HANIMOGLU[1]
Lale HANCI[2]
Mehmet Yasar KAYNAR[3]
Murat HANCI[4]

[1,3,4] I.U. Cerrahpaşa Medical Faculty, Neurosurgery Department, Istanbul, Turkey
[2] Bone and Joint Disorders Research and Education Hospital, Neurosurgery, Istanbul, Turkey

Received : 15.04.2009
Accepted : 27.07.2009

Correspondence address:
Hakan HANIMOGLU
E-mail:drhakanhanimoglu@hotmail.com

ABSTRACT

OBJECTIVE: Atlantoaxial stability can be achieved by laminar hook systems via posterior approach. This technique is much more safer than using screws. We presented our experience with the C1-C2 claw procedure.

METHODS and MATERIAL: Seven patients with atlantoaxial instability were operated by using C1 and C2 hooks, rods and transverse connector at Neurosurgery Clinic of Istanbul University Cerrahpasa Medical Faculty between the years 2005 and 2008.

RESULTS: Satisfactory stabilization was achieved in all patients. Operative complication or instrumentation failure was not observed.

CONCLUSIONS: C1-C2 claw is a safe technique and adequate stabilization is achieved with the use of a transverse connector.

KEYWORDS: Atlantoaxial instability, Claw systems, Transverse connector

ÖZ

AMAÇ: Atlantoaksiyel stabilite posteriordan kanca sistemlerinin kullanımı ile sağlanabilir. Bu teknik vida uygulamalarından çok daha güvenlidir. Biz, kliniğimizin, kancaların rodlar ve transvers bağlayıcılarla birleştirilmesiyle yapılan atlantoaksiyal füzyon deneyimlerini sunduk.

YÖNTEM ve GEREÇ: 2005 – 2008 yılları arasında, Istanbul Üniversitesi Cerrahpaşa Tip Fakültesi Nöroşirürji Kliniği'nde yedi hastada C1 ve C2 kancalar, rodlar ve transvers bağlayıcı kullanılarak C1-C2 füzyon sağlanmıştır.

BULGULAR: Tüm hastalarda yeterli stabilizaston sağlanmıştır. Cerrahi komplikasyon veya entrümantasyon problemi olmamıştır.

SONUÇ: Atlantoaksiyal pence uygulaması güvenli bir tekniktir ve transvers konnektör kullanımı ile yeterli stabilizasyon sağlanmaktadır

ANAHTAR SÖZCÜKLER: Atlantoaksiyal instabilite, Kanca sistemleri, Transvers bağlayıcı

INTRODUCTION

The atlantoaxial complex, bearing the weight of the head and the atlantoaxial joint, generates most of the rotation of the head and neck (14). In normal conditions this complex is very strong in spite of its high mobility. However, atlantoaxial instability generally needs to be fixed by surgical intervention in order to create a strong but immobile structure when it occurs.

Several posterior surgical approaches have been used to achieve atlantoaxial arthrodesis, such as the Gallie technique (1939), Brooks and Jenkins technique (1978), and interlaminar clamping (1982). In 1979, Magerl and Seemann reported the results of a posterior C1-C2 transarticular screw fixation technique (TAS) (2). Although the biomechanical superiority of transarticular screws over posterior wiring has been clearly established by numerous studies, the technique has several drawbacks. In this article, we present a modification of the old technique, where C1 and C2 hooks are interconnected with a transverse connector, thereby reinforcing the stability of the construct against rotational forces. We conclude that this construct provides adequate stability for fusion if the posterior elements are intact. We present 7 patients with atlantoaxial instability operated on by this technique.

PATIENTS and METHODS

Seven consecutive patients with upper cervical instability were treated between the years of 2005 and 2008 by the atlanto-axial claw procedure at the Neurosurgery Clinic of Istanbul University Cerrahpasa Medical Faculty. Details of the cases are listed on the (Table I). All patients were evaluated preoperatively with radiographs, computed tomography (CT), and magnetic resonance imaging.

Surgical Procedure:

All patients were positioned prone, with the head and cervical spine neutral on the horse-shoe head holder and/or Halo-West, if required. Exposure of the posterior upper cervical spine and craniometrical junction (C_0-C_3) 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 insertion sites of hooks were prepared using a periosteal elevator. The dissection was extended to the ring of C1 and below the inferior border of lamina of C2 to accommodate the hooks. The grafting sites were decorticated using a high-speed drill. After these preparations, suitable hooks were inserted carefully and rods placed over them and then compressed bilaterally. A transverse connector was placed between the C1 and C2 hooks. After meticulous haemostasis, a mixture of demineralised bone matrix and bone morphogenetic protein was placed all over the decorticated surfaces (Figure 1A,B), (Figure 2A,B).

Table I: Details of the cases

	Cause of instability	Preoperative Neurological Status	Complication	Follow-Up
6 / F	Dens Hypoplasia + atlantoaxial subluxation (minor trauma)	Frust paresis of right upper extremity	-	9 weeks no complaint
53/ F	C2 metastasis of Breast Cancer	Intact	-	4 months no complaint
16/F	Atlantoaxial subluxation + type III odontoid frx*(road accident)	Intact	-	37 months no complaint
16/M	Atlantoaxial subluxation (road accident)	Intact	Superficial skin infection	28 months no complaint
53/M	Atlantoaxial subluxation + rheumatoid artritis	Quadriparesis Upper: 2/5 Lower:2/5	-	42 months Self mobilization with one cane
60/F	Atlantoaxial subluxation + rheumatoid artritis	Quadriparesis Upper: 3/5 Lower:4/5	Transient Chest Pain	Operated 26 months ago, Last follow-up 12th month: no complaint
20/M	Os odontoideum+ atlantoaxial subluxation (road accident)	GCS**: 7/15 Multiple ICH	-	1 week GCS**: 12/15

*frx: fracture, **GCS: Glascow coma scale

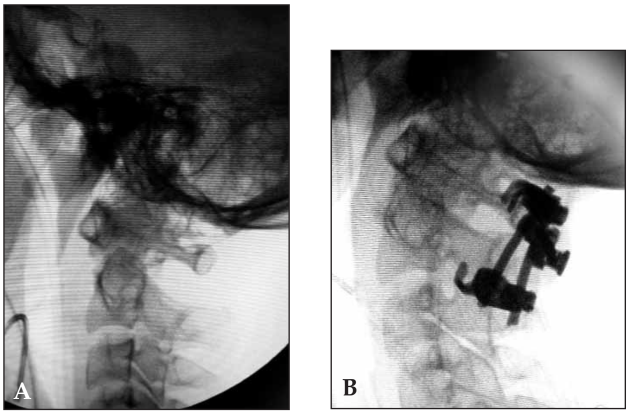

Figure 1: ***A.*** *Preoperative lateral X-Ray of seventh patient. Obvious atlantoaxial instability seen. Please note that there is increased posterior atlantoaxial distance and anterior displacement of atlas and tip of odontoid process.* ***B.*** *Postoperative lateral X-Ray of same patient. Note that reduction is achieved.*

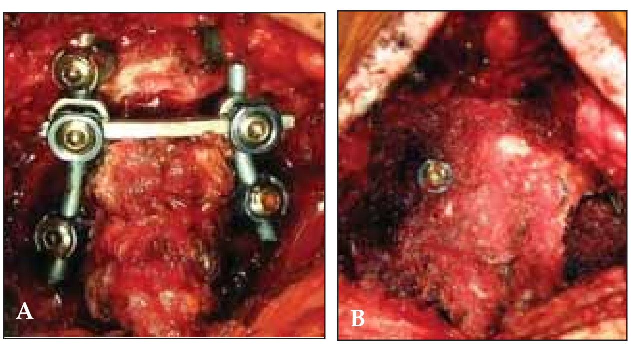

Figure 2: ***A.*** *Intraoperative picture of seventh patient showing construct that is done by C1 and C2 hooks interconnected by 2 rods and one transverse connector.* ***B.*** *Intraoperative picture of same patient after bone allograft are placed . We don't use drainage tube after that stage.*

RESULTS

Satisfactory stabilization and reduction was achieved in all patients. There were no spinal cord injuries due to hook placement under the lamina. No peroperative or early postoperative instrumentation failure was observed.

DISCUSSION

Atlantoaxial fusion was first described by Mixter and Osgood (8) in 1910 using braided sutures. Gallie revised this technique using wire and bone graft. Brooks and Jenkins further described double graft compression between the lamina of the atlas and axis with a sublaminar wire. Grob and Magerl (9) introduced the transarticular technique, a technically difficult procedure, with the added risk of inadvertent injury to the vertebral artery not inherent in wiring techniques. The technique of atlantoaxial fusion through C1 lateral mass and C2 pedicle with screws, which was first described by Goel et al. (3,4,5,7) and then subsequently popularized by Harms and Melcher (10), reduced the risk of injury to the vertebral artery. Another modification of this crossed intralaminar fixation described by Wright (15) reduced the complications yet further.

Various surgical methods have been described for the surgical treatment of atlantoaxial instability since the 1939 Gallie technique with sublaminar wires. All the methods that used wires only did not succeed in overcoming the disadvantages. These techniques do not provide sufficient immobilization of the atlantoaxial complex, thus resulting in non-union rates up to 30% even with adjunctive halo vest immobilization (6). Increasing the number of wires would mean more manipulation within the spinal canal and therefore additional risk of neural tissue damage.

Screw fixation techniques were developed after wiring techniques. Biomechanically, transarticular screws are superior to wiring techniques (13). The transarticular screw fixation technique was first described by Magerl and Seemann in 1986 and led to significant improvements in fusion rates. This technique requires reduction of C1 on C2 before screw placement. Achieving the proper placement of the screws and avoiding injury to the vertebral artery are technically demanding procedures. Additionally, proper allowance of the drill whilst accessing the insertion point on C2 can be restricted in some cases by the patient's osseous axial anatomy, e.g., pronounced thoracic kyphosis. Approximately 20% of patients requiring atlantoaxial fusion display anatomic variations in the course of the vertebral artery and in the osseous anatomy, at least on one side, precluding screw placement(1). To maximize the stability, the transarticular screw fixation has to be combined with either a Gallie or a Brooks's fusion. This increases the risk of neural injury caused by the passage of wires or cables into the spinal canal. Transarticular fixation with combination of wiring therefore does not attenuate the neural damage risk and, on the contrary, the additional risk of vascular damage arises. However, excellent biomechanical stabilization is acquired making halo application is inessential and perfect union rates are achieved. The technique described by Goel et al. in which atlantoaxial fusion is attained through the use of C1 lateral mass and C2 pedicle with screws reduced the rate of injury to the vertebral artery, but the risk is still being present. Another advantage of this technique is that any additional wiring is not necessary, but malposition of the pedicle screws also carries a risk of neural damage and a case has been reported.

Posterior interlaminar clamps can be used if the C1-C2 laminas are intact. Without a transverse connector, laminar clamps biomechanically provide reliable stability with flexion and extension maneuvers. However, the clamps are not as effective as in any other technique involving posterior screws with or without wires in rotational motion. Halo immobilization for at least 3 months is also recommended with Halifax interlaminar systems (11).

A study by Harms et al. introduced the biomechanical properties of a novel C1 posterior locking plate applied with his own technique, while comparing it to the conventional C1 lateral mass to C2 pars screw fixation. This study concluded that the C1 locking plate technique functioned in an equivalent manner as the existing Harms technique. The C1 plate may be a viable alternative that is technically less demanding and possessing lower surgical risk. The system encloses only the posterior bony elements of atlas and axis. The interlocking plate behaves as a transverse connector (12).

We presented seven patients treated by C1-C2 claws interconnected by a transverse connector. This technique is superior to wiring techniques mainly because there is no need for a halo-vest application. All seven patients used a cervical collar after the surgery and the strength of the construct was adequate. The transverse connector reinforces the stability of the construct against rotational forces. The possibility of vertebral artery damage is nearly zero with this technique. The major disadvantage of this technique is the need for intact posterior bony elements.

CONCLUSION

Despite of our small patient population, we conclude that the bilateral C1-C2 claw system interconnected with a transverse connector is a safe, simple and an alternative method to achieve rigid and immediate atlantoaxial stabilization which can be executed without any risk of vertebral injury.

REFERENCES

1. Acosta FL Jr, Quinones-Hinojosa A, Gadkary CA, Schmidt MH, Chin CT, Ames CP, Rosenberg WS, Weinstein P: Frameless stereotactic image-guided C1-C2 transarticular screw fixation for atlantoaxial instability: Review of 20 patients. J Spinal Disord Tech 18:385-391, 2005
2. Fountas KN, Kapsalaki EZ,Karampelas I, Dimopoulos VG, Feltes CH, Kassam M A,Boev AN, Johnston K W, Smisson HF, Troup E C, Robinson JS: C1-C2 transarticular screw fixation for atlantoaxial instability. South Med J 97:1042-1048, 2004
3. Goel A: C1-C2 pedicle screw fixation with rigid cantilever beam construct: case report and technical note. Neurosurgery 51: 853–854, 2002
4. Goel A, Achawal S: The surgical treatment of Chiari malformation association with atlantoaxial dislocation. Br J Neurosurg 9: 67–72, 1995
5. Goel A, Laheri V: Plate and screw fixation for atlanto-axial subluxation. Acta Neurochir (Wien) 129:47–53, 1994
6. Goel A, Laheri V, Harms J, Melcher P: Posterior C1-C2 fusion with polyaxial screw and rod fixation. Spine 27:1589-1590, 2002
7. Goel A, Muzumdar D, Dindorkar K, Desai K: Atlantoaxial dislocation associated with stenosis of canal at atlas. J Postgrad Med 43: 75–77 1997
8. Goel VK, Winterbottom JM, Schulte KR, Chang H, Gilberson LG, Pudgil AG, Gwon JK: Ligamentous laxity across C0-C1-C2 complex. Axial torque-rotation characteristics until failure. Spine 15:990–996, 1990
9. Grob D, Magerl F: Surgical stabilization of C1 and C2 fractures. Orthopade 16: 46–54, 1987
10. Harms J, Melcher RP: Posterior C1–C2 Fusion with polyaxial screw and rod fixation. Spine 27:1589-1590, 2002
11. Huang CI, Chen IH: Atlantoaxial arthrodesis using Halifax interlaminar clamps reinforced by halo vest immobilization: a long-term follow-up experience. Neurosurgery 38:1153-1156, 1996
12. Kelly BP, Glaser JA, DiAngelo DJ Biomechanical comparison of a novel C1 posterior locking plate with the harms technique in a C1-C2 fixation model. Spine 33:E920-925, 2008
13. Naderi S, Crawford NR, Song GS, Sontag VK, Dickman CA: Biomechanical comparison of C1-C2 posterior fixations. Cable, graft, and screw combinations. Spine 23:1946–1955, 1998
14. Pang D, Li V: Atlantoaxial rotatory fixation: part 1—biomechanics of normal rotation at the atlantoaxial joint in children. Neurosurgery 55: 614-625, 2004
15. Wright NM: Posterior C2 fixation using bilateral, crossing C2 laminar screws: case series and technical note. J Spinal Disord Tech 17:158–162, 2004