Posterior C1-C2 Transarticular Screw Fixation for Atlanto-Axial Instability

SAWING PANJAISEE, M.D.*

Abstract

The objective of this study was to reveal that the treatment of C1-C2 instability by transarticular C1-C2 screw fixation with bone graft has a better result than conventional sublaminar wiring with bone graft by Gallie's technique. This technique, proposed by Magerl and Semann in 1987, produces a rigid three points fixation resulting in maximal bone fusion rate and does not require an orthosis post-operatively. This technique is performed in patients with fractured lamina of C1 or in patients who need a laminectomy of C1 for spinal cord decompression. This study revealed 10 patients having C1-C2 instability who were operated on by transarticular C1-C2 screw fixation with bone graft. No complication was encountered. No screw and bone graft slipping were noted. The patients were improved clinically and the average follow-up period was 7.7 months. There were 2 cases which had previously been operated on for sublaminar wiring but the operation was unsuccessful because there was a fractured lamina of C1. Both patients were sent to Prasat Neurological Institute & Hospital for transarticular C1-C2 screw fixation. Another 2 cases were operated on for sublaminar wiring with bone graft. The follow-up X-ray of both cases disclosed a displacement of C1-C2. Lost of C1 lamina was found in one case and there was slipping of wire in another case, because of this the patients were re-explored for transarticular C1-C2 screw fixation with bone graft. The conclusion is, this technique of transarticular C1-C2 screw fixation, is the best surgical treatment for C1-C2 instability, in the hands of experienced surgeons with an excellent knowledge of anatomy.

Key word : Sublaminar Wiring, Rigid Three Points Fixation, Transarticular Screw Fixation, Bone Graft

PANJAISEE S
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Atlanto - axial instability may be caused by many factors such as trauma, tumor, congenital anomaly, infection and inflammation. The clinical manifestations may be neck pain or neurological deficit such as quadriparesis or quadriplegia or sudden death[1]. Other features such as syncope

* Department of Neurosurgery, Prasat Neurological Institute & Hospital, Bangkok 10400, Thailand.

may be presented because of vertebral artery injury which was found in patient number 7. Diagnosis of this condition should be kept in mind, especially in cases of traumatic fracture of C-spine.

The treatment of Atlanto-axial instability began in 1937 by Gallie using sublaminar C1-C2 wiring, which could not prevent translational and rotational movement[2,3]. In 1978, Brooks and Jerkins employed wedge compression with bone graft and sublaminar C1-C2 wiring. This technique prevented rotational movement better than Gallie's technique[2-5]. After that an interspinous technique was developed from Brook's technique by using bicortical bone graft between C1-C2 sublaminar wiring to reduce risks of neurological deficit[6]. However, C1-C2 sublaminar wiring cannot be used in C1 laminectomy or in fractured posterior arch of C1. From the study of biomechanics of C1-C2 wiring, it was found that C1-C2 wiring had semi-rigid fixation with moderate translation and rotation, as well as a non - union rate of 10-30 per cent and a Halo-brace after operation to improve fusion rate had to be employed[3-6]. In 1987, Magerl and Semann proposed the posterior transarticular screw fixation of C1-C2 technique and found that this technique had 3-point fixation (rigid fixation) with maximal fusion rate[3-6]. Hence, this technique should be the best technique in the treatment of C1-C2 instability, but surgeons should possess good technique and experience to avoid injury to the vertebral artery and the spinal cord. From a retrospective study injury to the vertebral artery was found in 2.2 per cent per screw or 4.1 per cent per patients[7]. In Prasat Neurological Institute & Hospital we began to use the posterior C1-C2 transarticular screw fixation technique in patients with C1-C2 instability in 1996. The objective of this study was to compare the results from transarticular C1-C2 screw fixation technique and posterior C1-C2 sublamina wiring.

MATERIAL AND METHOD

The diagnosis of patients sustaining C1-C2 instability was substantiated by X-ray films of the lateral cervical spine with flexion and extension view showing atlantodental interval (ADI) > 3 mm. From 1996, 10 cases were operated on by transarticular C1-C2 screw fixation together with posterior wiring and bone graft in Prasat Neurological Institute & Hospital. Clinical and X-ray follow-up were carried out 1 week and 3 months after surgery.

The clinical presentation and operative treatment are demonstrated in Table 1.

Surgical procedure[1-4,8]

The patient was anesthetized and intubated in the supine position. Bone graft was taken from the iliac crest. The patient was then turned to the prone position on Wilson's frame, and the patient's head was slightly extended on a horseshoe headrest.

A straight midline incision was made from the occiput to C7. Subperiosteal dissection was carried out to separate the paravertebral muscle from the spinous process until C1, C2, C3 lamina and C1-C2, C2-C3 facet joint were exposed. Bipolar coagulation was used to stop bleeding and gelfoam was placed on venous bleeding sites at C1-C2 junction.

After correct alignment of C1-C2 was obtained under fluoroscopic guide, the entry point of the screw was marked, which was on each side of the inferior articular process of C2, about 2-3 mm above the facet joint C2-C3 and 2-3 mm lateral to the medial border of facet joint C2 – C3 (as Fig. 1). The pins, 2 mm in diameter, were drilled in the sagittal plane under fluoroscope aimed at the anterior tubercle of C1 about 4-4.5 cm in length on both sides. The pins will penetrate the facet joint of C1-C2 but will not penetrate the spinal cord medially nor the vertebral artery laterally. A pin on either side was then removed with another pin still in place to fix the bones.

The screw 4-4.5 cm in length, was fixed into the hole. The remaining pin was then removed and was replaced by a fixation screw. After fixing both screws, the posterior C1-C2 wiring with iliac bone graft using Gallie's technique was performed. For cases of fractured C1 lamina or C1 laminectomy, the bone graft was wired at the occiput and C2. A radivac drain was then inserted. The surgical wound was closed layer by layer. A post-operative collar was not used. The screw in the proper position must penetrate the lateral mass of C1 and C2 and the tip of the screw should emerge from the anterior arch of C1 not more than 5 mm[9].

RESULT

From 1996, 10 patients were diagnosed with C1-C2 instability. Five cases were diagnosed from plain film C-spine, 4 cases from MRI C-spine and 1 case from CT scan. Surgical correction was performed by transarticular screw fixation of C1-C2

Table 1. The clinical presentation and operative treatment of 10 cases of patient.

Case	Sex	Age	Problem	Operation	Result
1	Male	32	Os odontoideum, C1 – C2 dislocation Quadriparesis Cervicomedullary narrowing	Laminectomy C1 Transarticular screw fixation C1-C2 Wiring occiput – C2 & bone graft	Good
2	Male	65	C1 – C2 dislocation Cervicomedullary narrowing Quadriparesis Transoral odontoidectomy	Laminectomy C1 Transarticular screw fixation C1-C2 Wiring occiput-C2 & bone graft	Good
3	Male	56	C1-C2 dislocation Cervicomedullary narrowing Quadriparesis	Laminectomy C1 Transarticular screw fixftion C1-C2 Wiring occiput-C2 & bone graft	Good
4	Male	23	C1-C2 dislocation Quadriparesis s/p posterior wiring with iliac bone graft Loss of C1 lamina	Transarticular screw fixation C1-C2 Wiring occiput-C2 & bone graft	Good
5	Female	56	C1-C2dislocation Severe neck pain	Transarticular screw fixation C1-C2 Posterior wiring C1-C2 & bone graft	Good
6	Female	46	C1-C2 dislocation, Quadriparesis, s/p posterior wiring with iliac one graft wiring slipped off	Transarticular screw fixation C1-C2 Posterior wiring C1-C2 & bone graft	Good
7	Male	51	C1-C2 dislocation Failure of posterior wiring C1-C2 (fractured C1 lamina Syncope	Transarticular screw fixation C1-C2 Posterior wiring occiput-C2 & bone graft	Good
8	Female	32	C1-C2 dislocation Severe neck pain	Transarticular screw fixation C1-C2 Posterior wiring C1-C2 & bone graft	Good
9	Male	46	C1-C2 dilocation Quadriparesis Failure of posterior wiring C1-C2 (fractured C1 lamina)	Transarticular screw fixation C1 – C2 Posterior wiring occiput – C2 & bone graft	Good
10	Male	66	C1-C2 dislocation Quadriparesis	Transarticular screw fixation C1-C2 Posterior wiring C1-C2 & bone graft	Good

together with posterior wiring with iliac bone graft (Fig. 2). In cases of fractured C1 lamina or C1 laminectomy for decompression of cervical spinal cord, we used bone graft fusion at the occiput and C2. The patients were aged between 23 and 66 years. There were 7 males and 3 females. Follow-up was from 1 to 23 months. All 10 cases had decreased neck pain and neurological deficit. In addition, after X-ray follow-up every case had neither screw displacement nor bone graft slipping. There were 2 cases which had previously been operated on by Posterior wiring C1-C2, but follow-up film demonstrated slipping of the wire and non fusion of the fracture site (Fig. 3). There were 2 cases of fractured C1 lamina (Fig. 4) where wiring could not be performed, so the patients were transferred to our hospital for surgical management. There was 1 case with active bleeding from the hole when the pin was removed before the screw was inserted, however, the bleeding was stopped when the screw was put in place. For this case, there is no post-operative vertebral angiography to demonstrate whether there was vertebral arterial injury or not. However, the patient did not have any postoperative complication, but we had to reexplore to reposition one screw because of malposition of the screw.

DISCUSSION

Instability of atlanto-axial joint is caused by incompetence of the odontoid process or transverse ligament in traumatic patients. The doctor must always be aware that the patient may have cervical spine injury, because if a patient with cervical spine injury is moved to the hospital without awareness demage to the spinal cord can occur.

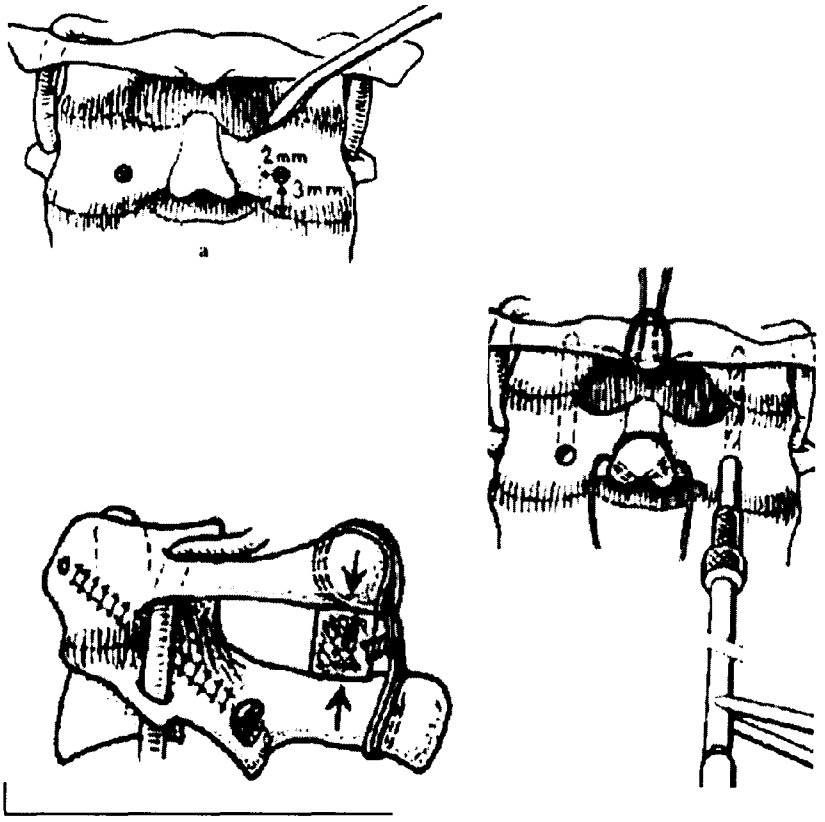

Fig. 1. Operative technique.

As a result, the patient may succumb to sudden death or increased neurological deficit. The diagnosis may be established from symptoms such as neck pain or neurological deficit or reliable laboratory results such as plain films of lateral cervical spine with flexion and extension views in which ADI exceeds 3 mm. Should there be no indication of cervical spine injury, special investigation such as MRI or computerized tomography of the cervical spine might help in making the diagnosis.

It is now acceptable that surgical treatment has better results than non-operative treatment because it not only reduces the instability of the spine but also decompresses the spinal cord, and in cases of pure ligamentous injury, where the healing process is incomplete by non-operative teatment, to restore structural support. There are many operative techniques to stabilise C1-C2 such as the conventional technique of sublaminar wiring and bone graft or Halifax clamp using a hook to lock the laminae. But in cases of fractured C1 lamina or cases that need C1 laminectomy for decompression, sublaminar wiring or Halfax clamp cannot be used. Moreover, these techniques do not provide rigid fixation and must use rigid orthosis postoperatively. Thus, transarticular screw fixation of C1-C2 which has 3-point fixation without the need for postoperative rigid orthosis is the technique of choice. A previous study revealed that the technique had complication of vertebral artery injury in about 2.2 per cent per screw and spinal cord injury in about 0.1 per cent per screw. This study showed 2 cases that had been operated on before by sublaminar wiring with bone graft (Gallie's technique). One case (case No.4) had loss of C1 lamina and in the other case (case No.6) the wire had slipped off. Both cases were reexplored using C1-C2 transarticular screw fixation and had good results. There were 2 cases (cases No.7,9), that were originally planned for sublaminar wiring but C1 laminar frac-

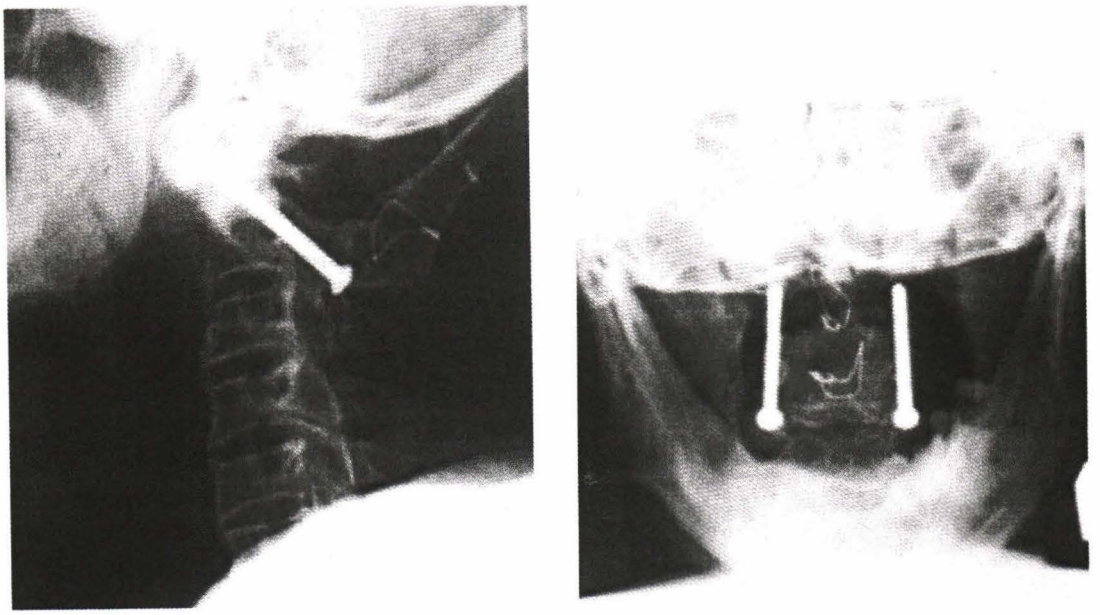

Fig. 2. Transarticular screw fixation C1-C2, postoperative films.

Fig. 3. C1-C2 Wiring slipped.

ture was found and the operation was cancelled before the patients were sent to our hospital where transarticular screw fixation of C1-C2 was carried out with good results. There was no complication in this study. Only one case had active bleeding from the hole when the pin was removed but it stopped completely when the screw was put in place. There was no postoperative angiography to demonstrate whether there was injury to the vertebral artery or not, however, the patient had no symptom or neurological deficit.

In our opinion, Transarticular screw fixation of C1-C2 is the technique of choice for the treatment of C1-C2 instability. It has fewer complications and does not need postoperative orthosis. However, it demands an experienced surgeon, with good technique and a wealth of surgical anatomy.

SUMMARY

The surgical technique for C1-C2 instability is now accepted as having a better result than non-operative treatment. This study was presented to signify that the transarticular screw fixation C1-C2 with iliac bone graft is better than conventional sublaminar wiring with bone graft (Gallie's technique) because of the following:

1. This technique has immediate rigid fixation and does not need postoperative orthosis.

2. No screw loosening when compared with sublaminar wiring slipping.

3. Can be used when there is lamina C1 fracture.

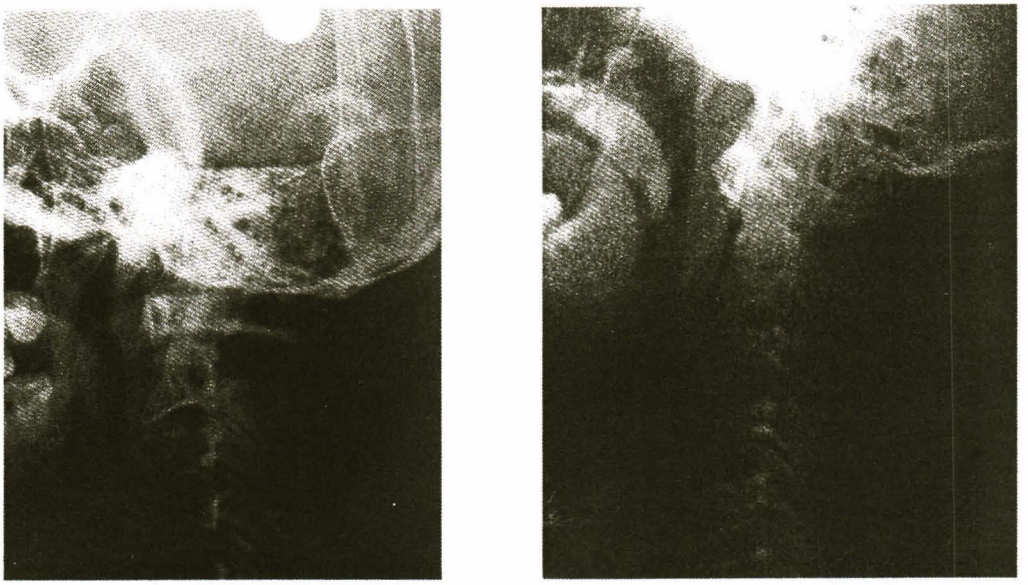

Fig. 4. Fractured C1 lamina.

4. Can be used when C1 laminectomy for decompression is needed.

5. Because this technique has rigid fixation the rate of bone graft fusion is improved.

6. There are fewer complication with this technique in the hands of experienced surgeons. So this technique should be adopted. In additon, the screw cost is inexpensive.

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การผ่าตัดกระดูกคอแอทลาสและแอกซิสเคลื่อนโดยวิธีการยึดตรึงข้อต่อของกระดูกแอทลาสและแอกซิสด้วยสกรู†

*สวิง ปันจัยสีห์, พ.บ.**

จุดประสงค์ของการศึกษาครั้งนี้ เพื่อชี้ให้เห็นว่า การผ่าตัดโดยวิธี Transarticular C1–C2 screw fixation with bone graft ในผู้ป่วย C1–C2 instability เป็นวิธีที่ดีกว่าวิธีดั้งเดิมคือ Sublaminar wiring with bone graft ของ Gallie's technique วิธีนี้เป็นวิธีใหม่ที่เสนอโดย Magerl & Semann ในปี ค.ศ. 1987 พบว่าวิธีนี้ มีคุณสมบัติเป็น 3 points fixation (rigid fixation) ทำให้เกิด Bone fusion rate สูง และไม่ต้องการ rigid orthosis หลังผ่าตัด นอกจากนี้ยังสามารถใช้ได้ในผู้ป่วยที่มี fractured lamina C1 หรือผู้ป่วย ที่ต้องการทำ laminectomy C1 เพื่อ decompression รายงานนี้เสนอผู้ป่วยทั้งหมด 10 ราย ซึ่งเป็น C1–C2 instability ที่ได้รับการผ่าตัดโดยวิธี transarticular C1–C2 screw fixation ทุกรายไม่มี complication หลังผ่าตัดและมีอาการดีขึ้นระยะเวลา follow-up ผู้ป่วยโดยเฉลี่ย 7.7 เดือน screw และ bone graft ไม่หลุดเลย มีผู้ป่วย 2 รายที่ผ่าตัด sublaminar wiring with bone graft จากโรงพยาบาลอื่น แต่พบว่ามี fractured lamina C1 จึงส่งมาให้โรงพยาบาลประสาทวิทยา เพื่อผ่าตัด transarticular C1 – C2 screw fixation นอกจากนี้ยังมีผู้ป่วยอีก 2 ราย ที่ทำผ่าตัด sublaminar wiring with bone graft แล้ว ปรากฏว่ามีการเคลื่อนที่ของ C1–C2 เนื่องจากรายหนึ่งมีการสูญหายของ lamina C1 อีกรายพบว่ามีการเลื่อนหลุดของลวดที่มัด จึงได้ทำการผ่าตัดโดยวิธี transarticular C1–C2 screw fixation ดังนั้นวิธีผ่าตัด transarticular C1–C2 screw fixation จึงเป็นวิธีที่ดีที่สุดในการผ่าตัด C1–C2 instability เพียงแต่ว่าแพทย์ผู้ผ่าตัด ต้องมีความชำนาญ และมีความรู้ทางกายวิภาคศาสตร์เป็นอย่างดี

คำสำคัญ : ยึดตรึงข้อต่อของกระดูกแอทลาสและแอกซิส, การติดตรึงของกระดูก, การเชื่อมของกระดูก

สวิง ปันจัยสีห์
จดหมายเหตุทางแพทย์ ฯ 2544; 84: 525–531

* หน่วยประสาทศัลยกรรม, สถาบันประสาทวิทยา, กรุงเทพ ฯ 10400

† ได้เสนอรายงานนี้ในการประชุมประจำปีของราชวิทยาลัยศัลยแพทย์แห่งประเทศไทย เมื่อวันที่ 14 – 16 กรกฎาคม 2543 ที่โรงแรมโรยัลคลิฟ พัทยา จ. ชลบุรี