Posterior cervical decompressive laminectomy and lateral mass screw fixation

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ABSTRACT

الأهداف: مراجعة نتائج ومضاعفات عملية استئصال الصحيفة الفقرية الرقبية لتخفيف الضغط، بالإضافة إلى نتائج تثبيت الفقرات باستخدام البراغي في الكتلة الجانبية للفقرات.

الطريقة: أُجريت هذه الدراسة الاسترجاعية في مستشفى الملك عبدالله الجامعي، أربيد، الأردن وذلك خلال الفترة من أكتوبر 2006م إلى يناير 2010م. شملت الدراسة 50 مريضاً ممن تتراوح أعمارهم ما بين 22–65 عاماً (17 أنثى، و33 ذكر)، كما أنهم يعانون من مجموعة من الأمراض الرقبية المختلفة مثل: الأمراض التنكسية، والرضوح، والأورام. لقد قمنا بوضع 405 برغي في الكتلة الجانبية للفقرات لهؤلاء المرضى على مدى 40 شهراً، وتم استخدام البراغي متعددة المحاور مع عمود في جميع الحالات التي شملتها الدراسة، وكان طول هذه المسامير 14 مم، وعرضها 3.5 مم. لقد تم تقييم مواضع المسامير بواسطة الأشعة والتصوير الطبقي بعد إجراء العملية الجراحية، بالإضافة إلى ذلك فقد تم تقييم حالة كلاً من: مفصل الرقبة الوجيهي، وقناة العصب، والثقبة المستعرضة.

النتائج: لقد تم استخدام طريقة أندرسون أو سبيكون من أجل تثبيت البراغي. أشارت نتائج الدراسة إلى عدم إصابة أي من المرضى بأضرار في الأعصاب أو الأوعية الدموية، فيما احتاج مريض واحد إلى تعديل موضع البراغي، وعانى 3 مرضى من التهاب سطحي، وعاني 5 مرضى من آلام حول الكتف في منطقة الفقرة الخامسة، وقد هدأ هذا الألم مع مرور الوقت. ولم يُصب أي من المرضى بانسحاب البراغي التي تم تثبيتها، أو مرض القطعة الفقرية المجاورة. أظهرت نتائج الأشعة المقطعية بعد إجراء العملية عدم تفاقم حالة الثقبة المستعرضة أو قناة العصب لدى غالبية المرضى، وقد كانت البراغي في وضعها المناسب.

خاتمة: أثبتت الدراسة أمان وفعالية تثبيت الفقرات باستخدام البراغي في الكتلة الجانبية، وهكذا فإن لهذه الطريقة أثراً فعالاً عند علاج أمراض العمود الفقري الرقبي.

Objective: To review the results and complications of cervical decompressive laminectomy and lateral mass screw fixation.

Methods: This retrospective study was carried out between October 2006 and January 2010 at King Abdullah University Hospital, Irbid, Jordan. Over 40 months, 405 lateral mass screws were placed in 50 patients aged 22-65 years (17 females, and 33 males) for variable cervical pathologies including degenerative disease, trauma, and neoplasm. All cases were performed with a polyaxial screw/rod construct. Most patients had 14 mm length and 3.5 mm diameter screws placed. The screw location was evaluated by postoperative plain x-ray and CT. The facet joint, foraminal and foramen transversarium violation were also assessed.

Results: All screws were placed using the Anderson or Sekhon methods. No patients experienced neural or vascular injury as a result of screw position. One patient needed screw repositioning. Three patients experienced superficial wound infection. Five patients experienced pain around the shoulder of C5 distribution that subsided over time. No patients had screw pullouts or symptomatic adjacent segment disease. Postoperative CT scanning showed no compromise of the foramen transversarium or neural foramen in the vast majority of the patients.

Conclusions: Lateral mass screw stabilization is a safe and effective surgical technique. This study exhibits the safety and effectiveness of lateral mass fixation for a variety of subaxial cervical spine disease.

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Roy-Camille et al, in 1979,[1] introduced posterior cervical fixation with lateral mass screws, and it has been increasingly used since that time to treat a wide range of cervical spine disorders. Posterior cervical fixation was frequently involved in forms of wire and bone construct fixation, with a proven long-

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term effectiveness requiring no special skills or x-ray guidance.[2-4] Posterior cervical wire fixation may not be efficient in the osteoporotic patient, as this surgical method can compromise the posterior cervical parts resulting in aggravation of the primary pathology and worsening of the neurological status requiring adequate fixation using the lateral mass fixation technique.[5-7] Furthermore, stainless-steel wire can also interfere with postoperative MRI results, in contrast to the MRI compatible titanium screw/rod constructs. Lateral mass screw fixation has advantages over standard posterior wiring techniques as it can be applied to patients with laminectomy, and can be performed easily for many levels with preservation of biomechanical forces. The fear of neural or vascular injury can explain the reservations of surgeons unfamiliar with this technique; however, this method does have the global acceptance of many surgeons.[8-10]

Our aim is to retrospectively evaluate 50 consecutive cases treated with decompressive cervical laminectomy and lateral mass fixation for a variety of cervical spine disorders. The operative and clinical outcomes, as well as postoperative CT analysis are provided with particular emphasis on neurological and vascular complications.

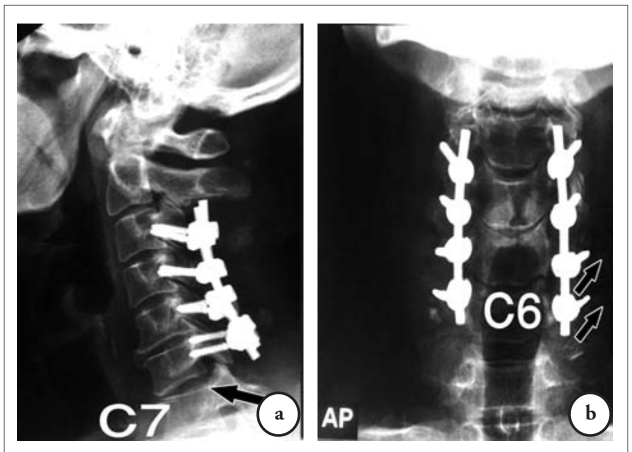

Figure 1 - Postoperative cervical spine x-ray showing **a**) lateral and **b**) anterior-lateral views of a patient who underwent decompressive cervical laminectomy and C3-C6 lateral mass fusion, the most common construct used for spondylotic myelopathy. The position of the screws is well demonstrated. Arrows show the direction of the screws.

Methods. The study was approved by the Ethical Committee for Human Research (IRB) at Jordan University of Science and Technology. Our study population consisted of 50 patients treated for multiple cervical pathologies at the King Abdullah University Hospital, Irbid, Jordan, between October 2006 and January 2010. Decompressive cervical laminectomy with a total of 405 lateral mass screws was applied in the subaxial levels between C3 and C7 to deal with degenerative disease, trauma, and neoplasms. Patients with congenital anomalies or active infection were not included in this study. The severity of cervical myelopathy was assessed using the Nurick scale.[11] The patient demographics were reviewed and analyzed in a retrospective manner.

Surgical technique. The surgical technique was used in the same manner for all cases. Fiberoptic intubation was considered for cases with severe stenosis and significant cervical myelopathy or gross instability. The lateral masses were drilled and tapped prior to laminectomy. Screw length was decided based on preoperative imaging assessment. The placement of screws was performed after cervical decompression. The screw direction was considered from standard trajectories. The entry point was approximately one mm medial to the midpoint of the lateral mass. Using a modified Anderson[8] or Sekhon technique,[12] the screws were angulated approximately 25^0 laterally and superiorly to achieve the best position of the lateral mass, and to minimize the risk of neural or vascular violation (**Figures 1a & 1b**). At C7, when the lateral mass was included in the fixation, more angulation was effected.

A variety of different implants were used including Vertex (Medtronic Sofamor-Danek, Minneapolis, MN, USA) and Oasys (Stryker Spine, Kalamazoo, MI, USA) polyaxial screw/rod constructs. All polyaxial screw/rod constructs were used adequately in the subaxial region. Screws of 12-14 mm length and 3.5 mm width were usually used for fixation in most cases. However, in certain cases, the lateral mass fixation was also incorporated as part of an occipitocervical or cervicothoracic fusion or as additional reinforcement for anterior constructs (**Figure 2**).

Intraoperatively, each screw position was assessed separately by imaging guidance before the final placement. In most cases, chips of auto-graft bone from the posterior elements were placed over the decorticated lateral masses and into the appropriate facet joints after screw insertion. Postoperatively, all patients were placed into a hard neck collar and underwent plain x-ray on the first postoperative day. Any intraoperative or postoperative clinical evidence of nerve root or vertebral artery violation was evaluated immediately by considering a thin-slice CT scan to evaluate all lateral mass screw positions, encroachment into the foramen transversarium, or into the neural foramen. Postoperatively, patients were evaluated clinically, and radiologically at 4 weeks, 2 months, 6 months, and 12 months. Follow-up, in this study, ranged from 3 months to 3 years. All myelopathic patients were discharged into a rehabilitation program.

No statistical tests were used, and only frequencies were calculated.

Table 1 - Demographics of 50 patients undergoing cervical decompressive laminectomy and lateral mass screw fixation.

Characteristics	n	(%)
Males	33	(66)
Females	17	(34)
Age range	22-65	
Average	46.8	
Indications		
Degenerative disease	38	(76)
Trauma	10	(20)
Neoplastic	2	(4)
Levels included		
C3-6	17	(34)
C4-6	25	(50)
C3-7	5	(10)
C4-7	2	(4)
C5-7	1	(2)

Results. The patient demographics are shown in **Table 1**; most patients were male, with an average age of 30-45 years. Some comorbidities were encountered and managed adequately. The 50 cases included in this report covered different pathologies, and the indications included: degenerative disease (38 cases), trauma (12 cases), and neoplastic spinal tumor (2 cases).

Intraoperatively, of the 405 lateral mass screws placed, there was no observation of vertebral artery injury or nerve root damage. Dural tear occurred in 4 cases that required intraoperative repair; all had severe cervical stenosis. The C7 could be adequately drilled with a steeper trajectory in 8 cases. Poor screw placement occurred in approximately 12 screws from lateral mass breakout in patients with osteoporotic bone that required conversion to another trajectory. Postoperatively, there was no clinical evidence of vertebral artery injury or further neurological damage. Five patients experienced a persistent C5 nerve root pain with a satisfactory postoperative CT scan showing no violation by the screws of the C4-C5 neural foramen, except in one female patient that required revision and her symptoms improved after surgical revision. The cause of postoperative C5 radicular pain from our experience seems to be due to aggressive foraminotomy or traction on the C5 nerve root because of posterior drift of the spinal cord that occurs after laminectomy. There were 3 cases with superficial infection, but no deep infection encountered. One case had CSF leak that we treated successfully with reinforcement sutures and lumber drain for 3 days. No patient experienced screw or rod pullouts. However, deep venous thrombosis was observed in 3 cases requiring inferior vena cava filter insertion and anti coagulation therapy; none of them developed pulmonary embolism or wound hematoma (**Table 2**). The results of the postoperative CT scan evaluation of screw position showed that 96% were position correctly, 4 (1%) screws violated the facet joint. Five (1.2%) screws breached the foramen transversarium by less than one mm, another 8 (1.9%) screws entered the neural foramen in variable levels. No screw breached the spinal canal. Follow up ranged from 3-38 months, with a mean of 18 months. Review after long term follow up of 3 years showed no patient developed adjacent segment symptoms or kyphosis. Patients with C5 radicular pain revealed a satisfactory response to facet joint block by using local steroid injection and amitriptyline pills. There was no instrumentation failure, and there was no late vascular or neural damage related to instrumentation.

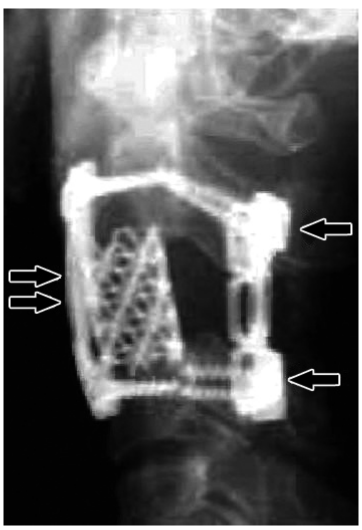

Figure 2 - Cervical 3-5 anterior and posterior spinal fixation after cervical 4 corpectomy and total resection of the spinal tumor from front and back in a staged operation (single arrow shows anterior, and double arrow shows posterior approach).

Discussion. The biomechanical stability of the subaxial cervical spine can be compromised by numerous pathological disorders, and the restoration of stability

Table 2 - Complications 50 patients undergoing cervical decompressive laminectomy and lateral mass screw fixation.

Characteristics	n	(%)
Root injury secondary screws	0	(0)
Vertebral artery injury	0	(0)
Dural tears	4	(8)
Superficial infection	3	(6)
Deep infection	0	(0)
Screw pullout or breakage (of 405 screws)	0	(0)
C5 root pain	5	(10)
Malposition that requires revision	1	(2)
Deep venous thrombosis	3	(6)
Pulmonary embolism	0	(0)
Adjacent segment requiring surgery	0	(0)
Hematoma requiring evacuation	0	(0)
Deaths	0	(0)

may ultimately require fixation and placement of hard fixation devices. Posterior cervical spine stabilization is often administered to treat cervical instability secondary to traumatic injury, inflammatory lesions, neoplastic disease, infections, and in cases with previous laminectomy. However, numerous surgical techniques and advances in spinal instrumentation have evolved over the last years. Lateral mass fixation has world widely gained popularity among spine surgeons with low morbidity and satisfactory outcome.[10,13] Sekhon[12] reported the largest series of subaxial lateral mass screw fixation with a total of 1024 screws and no related neuro-vascular injury observed.

Many screw insertion pathways have been described since Roy-Camille et al[1] first introduced lateral mass screw fixation. They advocated that the starting point is the midpoint of the lateral mass, and the direction of the screw is perpendicular to the posterior aspect of the cervical spine and 10^0 outward.[1] Anderson et al[8] recommended that the drilling point is one mm medial to the midpoint of the lateral mass, and that the screw is angled $30\text{-}40^0$ up, and 10^0 lateral, while Jeanneret et al[14] proposed a starting point 2-3 mm medial and superior to the midpoint of the lateral mass, and angling 30^0 superiorly and 25^0 laterally. An et al[15] suggested angling $15\text{-}18^0$ superiorly, and $30\text{-}33^0$ laterally, with a starting point one mm medial to the center of the lateral mass. Pait et al[16] divided the lateral mass into 4 quadrants, with the upper outer quadrant intended for screw insertion; in this way it is high likely to evade neurovascular injury.[16] Finally, Sekhon[12] recommended using Anderson et al's starting point and then angling 25^0 laterally and superiorly; this way is safe and easily applied. With regards to the lateral mass of C7, this can be attained with a steeper course without the need for the C7 pedicle.

Frequent clinical and cadaver investigations have been carried out on lateral mass fixation, focusing on various trajectories to achieve proper placement of the screw and to avoid neural and vascular damage. Ebraheim et al[17] in their cadaver study revealed the foramen transversarium is located in line with the midpoint of the lateral mass. Therefore, the direction of the screw should be lateral to avoid entry into the vertebral foramen.[17,18] The work carried out by Xu et al[19,20] concluded that An et al's[15] technique is highly likely to avoid neural damage compared with Jeanneret et al[14] and Anderson et al's[8] techniques. However, the incidence of nerve root violation when Roy-Camille et al,[1] Jeanneret et al,[14] or Sekhon's[12] trajectories are used is around 3.6%; this is most likely because of the lengthy screw and more lateral trajectory.[21]

In terms of screw length, Roy-Camille et al[1] recommended 14-17 mm. An et al[15] suggested that a screw length of 11 mm is effective. Sekhon[12] suggested that a 14-mm screw is safe and efficient based on the fact that the average vertical distance between the posterior midpoint of the lateral mass and the vertebral foramen from C3-C6 is approximately 9-12 mm. As a result, insertion of a 14 mm screw obliquely should cross the lateral mass smoothly. In addition to that, a 14 mm screw can be bicorticate, which adds further stability to the screw in place and causes no violation to the adjacent foramen. The cadaveric studies of Heller et al[22] concluded that bicorticate fixation with a large diameter and non-self tapping screws had the utmost resistance to pullout.[22-24]

In comparison with other fixation techniques such as cervical pedicle screws, lateral mass fixation is safer, has higher success rate, and low co-morbidities. In earlier studies, the failure rate was higher in patients who underwent screw/plate constructs compared with the newer polyaxial screw/rod systems. The former systems were semi constricted with no cross link, which augment the stability of the system. The newer polyaxial screw/rod systems are more constrained and essentially prevent screw pullout.[22,25,26]

In conclusion, wide decompressive cervical laminectomy with lateral mass fixation is a safe and reliable method of posterior stabilization, and proper for a wide range of cervical pathologies. In most cases, utilizing 12-14 mm length and 3.5 mm diameter screws are usually adequate. Neuro-vascular co morbidities are usually avoidable. On short-term follow up, cervical decompressive laminectomy with lateral mass fixation is effective. However, the long-term efficacy and outcome of decompressive cervical laminectomy with lateral mass fusion needs further evaluation.

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