http://dx.doi.org/10.5704/MOJ.1211.006

Comparison Of Lateral Mass Screw Fixation Technique And Hartshill Rectangle Technique In The Treatment Of Sub-Axial Cervical Spine Fractures

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ABSTRACT

Introduction: Cervical injury in a polytrauma patient is one of the most critical injuries. The aim of this study was to compare the lateral mass screw technique with the Hartshill rectangle technique for treatment of such cases. ***Materials and Methods:*** This prospective study consisted of 40 patients. Both groups were followed for three years clinically and radiologically. ***Results:*** In the lateral mass technique, there were no cases of vertebral artery injury, radiculopathy, screw pullout, dural tears, residual kyphosis or persistent pain. In the Hartshill technique 3 patients experienced intra-operative dural tears, 1 case of wire breakage at the six months follow up, 6 patients with persistent neck pain and 1 with worsening neurological status. One hundred per cent fusion was achieved in both groups. There was significant radiation exposure in the lateral mass group. Post-operative immobilisation was required only in the Hartshill. ***Conclusion:*** Lateral mass screw technique is definitely a relatively better procedure. But Hartshill rectangle still stands out in certain practical situations.

Key Words:
lateral mass, Hartshill

INTRODUCTION

Vertebral column injuries occur in approximately 6% of trauma patients, with half of these (2.6%) as spinal cord or nerve root level neurologic injuries[1]. Specific patient characteristics as well as the mechanism of injury influence the likelihood of a patient sustaining a cervical spine fracture[2]. The highest risk is in patients who manifest a focal neurologic deficit (20%). Other characteristics associated with an increased risk are age 50 years or above, high-energy trauma as mechanism of injury, and the presence of a head injury [2]. Interestingly, motion at the occipital-cervical junction is slightly increased by most cervical collars[3] and up to 38% of patients with severe closed head injuries can develop skin complications with prolonged use[4]. In most instances, it is imperative to operate on a sub-axial cervical spine fracture to improve healing and for stabilisation of the fracture. Lateral mass screw fixation is a contemporary option for treating such fractures. Although cervical facet wiring and interspinous wiring have become obsolete, the Hartshill rectangle with sublaminar wires is still widely used. The aim of this study was to review prospectively whether lateral mass screw technique is the safer and more effective fixation technique available for such fractures compared to management using the Hartshill rectangle.

MATERIALS AND METHODS

The study was conducted over a period of three years from 2008-2011. Patients were studied prospectively and follow-up included clinical and radiological evaluation. Out of the total of 55 patients with cervical trauma in that time period, 40 patients were included in the present study were (n=40). Inclusion criteria were: (a) patients between the age of 15-70y; (b) patient suffered post-traumatic cervical spine injury [fracture, dislocation (i.e. due to road traffic accident, direct fall, assault, industrial accident)] within levels C3-C7 who were candidates for only a posterior approach alone Exclusion criteria were: (a) patients with pathological fracture of the cervical spine; (b) concomitant non-traumatic cervical spine pathologies such as neoplasms, tuberculosis, osteoporosis and primary metabolic bone disease; (c) patients at high-risk group for surgical complications or who are otherwise medically unfit for surgery; (d) patients with burst fractures with retro-pulsed fragments for whom anterior approach was mandatory; (e) fractures involving C1-C2 (cases in which the two studied techniques could not be utilised); and (f) patients with concomitant spinal abnormalities such as ankylosing spondylitis, rheumatoid arthritis or diffuse idiopathic skeletal hyperostosis.

Thus, the cases included consisted of the following injuries: (a) facet joint dislocations (majority at C4-C5 and C5-C6 LEVEL); (b) dislocations with concomitant lamina fractures; (c) vertebral body tear-drop fractures (compression-flexion type 3 injuries for which computed tomography (CT) scan showed no intra-canal fragments; and d) compression

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fracture with kyphosis (evidence of posterior column disruption but no retropulsion) [5]. All patients were subjected to a CT-scan and the National Acute Spinal Cord Injury Study (NASCIS) protocol was used wherever applicable [6].

The two types of implants, Hartshill Rectangle and Lateral Mass Screw-Rod system, were used in 20 cases each to enable direct comparison. The midline extensile approach was used and autogenic bone grafts were used for fusion.

For the lateral mass screw fixation, we used 3.5 mm diameter titanium poly-axial screws with a rod system for all cases. We used the Magerl fixation technique [7] in which the screw was placed 2-3 mm medial and cephalad to the middle of the lateral mass. Thus, the screws were angulated to about 25° laterally and placed parallel to the superior articular facets. For the Hartshill rectangle application, the stainless steel Hartshill was used with sublaminar wires that ranged in size from 1.5-2mm in diameter. Patients were followed-up at the 6th, 8th and 12th week and then at three months, six months and one year. They were assessed clinically, radiologically and functionally.

Most patients were mobilised at around 2-6 months depending on the fusion status on follow-up x-rays. In addition to monitoring of fusion on follow-up x-rays, the other parameters that were evaluated included: possible complications of each procedure such as wire breakage, wire dislodgement, screw backout /pullout, and/or loss of sagittal alignment (residual kyphosis). Persistent pain was evaluated using the Oswestry Scale For Neck disability [8] for which the patient was given a Neck Disability Index Questionnaire and was graded on a scale of 50 points. Neurological status was assessed using the American Spinal Injury Association (ASIA) Scale [9] pre- and postoperatively. Change in the cervical curvature was assessed using the Ishihara curvature index (C.I.) [10] to check for loss of alignment on follow-up.
Fusion status on follow-up x-rays was noted and the fusion rate was compared for the two techniques. Evidence of fusion was graded on two criteria: (a) absence of obvious hardware loosening; and (b) absence of motion (less than 1 mm) between contiguous spinous processes on flexion/extension radiographs [11].

We used the t-test for the age groups and the Chi-square test for comparing differences between sexes. P-value of 0.05 or less was considered to be statistically significant for all analyses and comparisons.

RESULTS

In the present study, patient age ranged from 19- 60 years with mean age of 41.05 years in the lateral mass technique group and 40.95 years in the Hartshill group (Table I). Twenty-four (60%) of the 40 cases were male. Seventy to eighty per cent of all cases were rated C and D on the ASIA scale for each group as shown in Figure 1.

The profile of mechanism of injury was most commonly of Distractive Flexion type as illustrated in Table II. Sixty-five per cent of all cases had C4-C5 & C5-C6 region cervical injuries followed by 15% with C3 – C4 and 10- 15% with C4 and C5 wedge fractures, results that are comparable for the two groups.

Intraoperative and the postoperative complications associated with each procedure are shown in Table III. Intra-operatively, three patients (15%) in the Hartshill group suffered dural tears. All the tears were sutured intraoperatively and patients were then placed in a head-low position and monitored postoperatively. One of these patients suffered deterioration of the ASIA scale score from D to A [9]. All other patients had an unremarkable post-operative recovery. For those patients in whom we used the lateral mass screw technique, there were no intra-operative complications (i.e., vertebral artery injury, dural tears or screw loosening). However, patients were exposed to an average radiation time of 92.5 fsec (fluoroseconds, SD±6.95). On follow-up x-rays, there was one patient (5%) Hartshill Technique patient with wire breakage at the six months postoperative visit. Six Hartshill technique patients (30%) complained of persistent pain on follow-up. Postoperatively and on follow-up, in the lateral mass group, patients did not complain of radiculopathy, worsening of neurological deficit or persistent pain. These patients had no loss of alignment (residual kyphosis), screw pull-out or screw loosening. Two cases (10%) in each group had superficial infection postoperatively but in all cases, infection was controlled without any major consequence (Figure 2). The fusion rate in the study was 100%.

Out of the 20 Hartshill technique cases, 14 patients had no pain or disability according to the Oswestry Scale. However, there were 4 patients (20%) with mild disability and two patients (10%) had moderate disability (Figure 3). There were no such cases in the lateral mass group. There was no significant change in CI (Curvature Index) values immediately postoperatively and at the last follow-up in the Hartshill group indicating no loss of alignment (residual kyphosis).

DISCUSSION

Cervical fractures may necessitate anterior decompression and stabilisation with plate and cage. They may or may not be supplemented by a posterior stabilisation procedure. Certain fractures require only posterior stabilisation with rigid fusion. The Hartshill rectangle technique and Lateral mass screw fixation techniques were comparable in age, sex, level of injury to cervical spine, mechanism of injury and patients belonging to ASIA Scale category. A distinct advantage of the lateral mass screw technique was it can be used for a larger spectrum of sub-axial cervical spine injuries (Figure 4). Although both techniques can be used in the fixation of facet dislocation type of injuries and vertebral

Table I: Demographic data (12 males and 8 females in each group)

	Lateral mass technique (N=20)	Hartshill technique (N=20)
Parameters		
Mean	41.05	40.95
SD	11.2	14.1
Range	23 – 60	19 - 63

t-test = 0.0056 'p' VALUE=0.9956 > 0.05

Table II: Profile of Mechanism of injury(as per Allen's mechanistic classification)

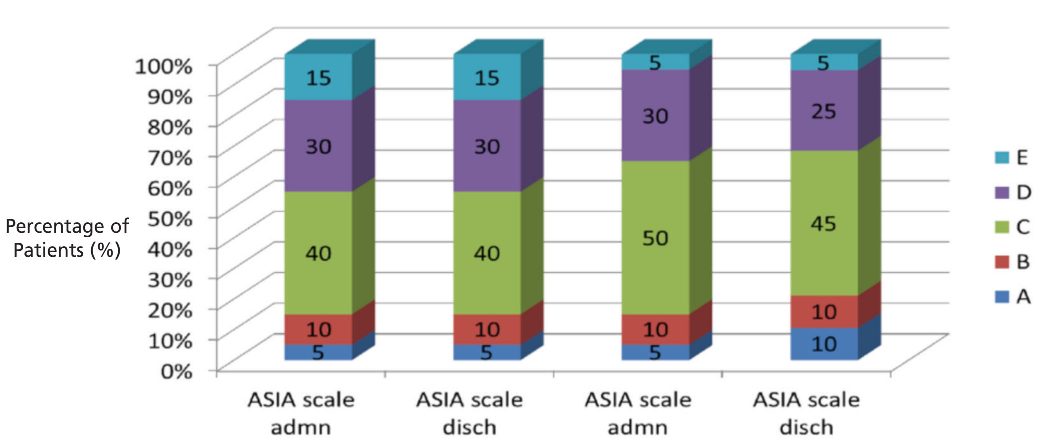
Mechanism of injury	Mechanism of injury (N=40) Lateral mass technique (N=20) No (%)	Hartshill technique(N=20) No (%)
Compression Extension (CE)	03 (15)	01 (5)
Compression Flexion (CF)	03 (15)	02 (10)
Distraction Flexion (DF)	14 (70)	17 (85)

Chi-Square test= 5.029 'p' VALUE=0.0809(> 0.05)

Table III: Complications(intra-operative and post-operative)

Complications	Intraoperative (N=20) No (%)		Follow-up (N=20) No (%)	
	Lateral mass technique No (%)	Hartshill technique No (%)	Lateral mass technique No (%)	Hartshill technique No (%)
Vertebral artery injury	- (-)	- (-)	- (-)	- (-)
Radiculopathy	- (-)	- (-)	- (-)	- (-)
Screw Pullout	- (-)	- (-)	- (-)	- (-)
Dural Tears	- (-)	03 (15)	- (-)	- (-)
Wire Breakage	- (-)	- (-)	- (-)	01 (5)
Wire Migration	- (-)	- (-)	- (-)	- (-)
Residual Kyphosis	- (-)	- (-)	- (-)	- (-)
Persistent Pain	- (-)	- (-)	- (-)	06 (30)
Infection			2 (10)	2 (10)
Worsened Neurodficit	- (-)	01 (05)	- (-)	- (-)

Radiation Exposure (*):
Mean (SD) 92.05 (6.05)
(*)- fluoroseconds



Lateral Mass Group Hartshill Group

Fig 1: Distribution of cases according to the ASIA scale for neurological assessment (on admission and discharge). [ASIA scale deteriorated in one patient in the Hartshill group from D to A]

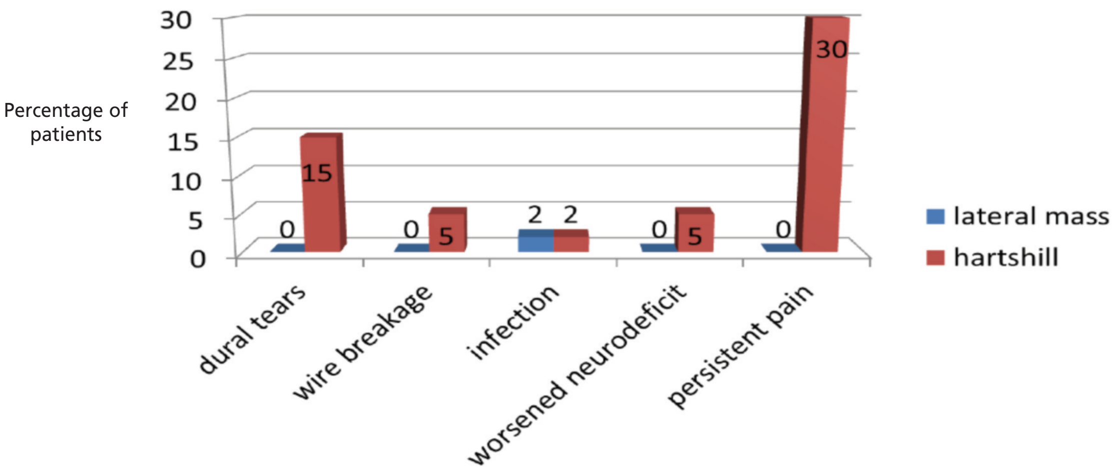


Fig 2: Percentage of complications

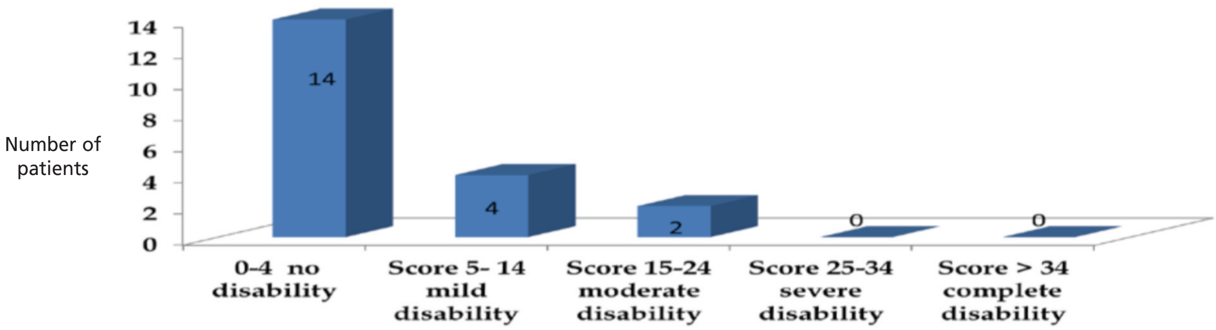


Fig 3: Oswestry Disability (Pain) Score(none in the Lateral Mass group)

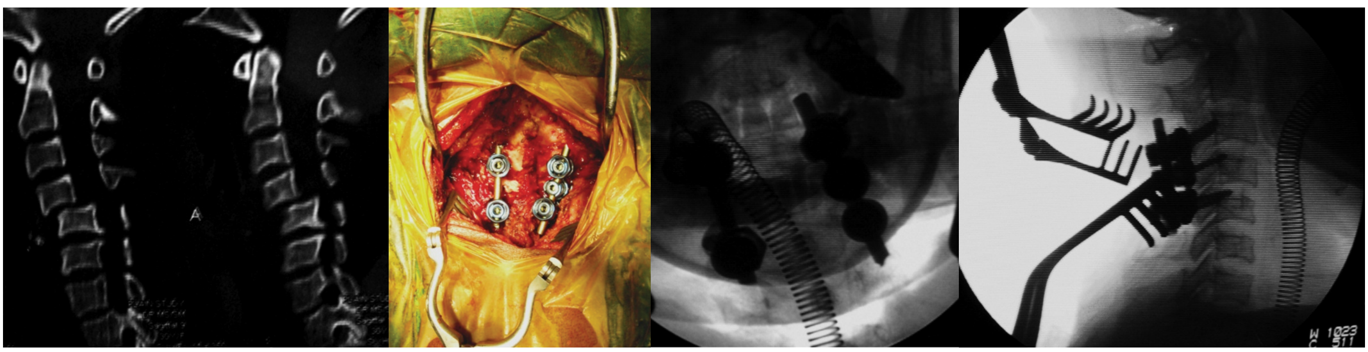


Fig 4: C4-C5 Dislocation where the lamina was fractures at the middle level on one side

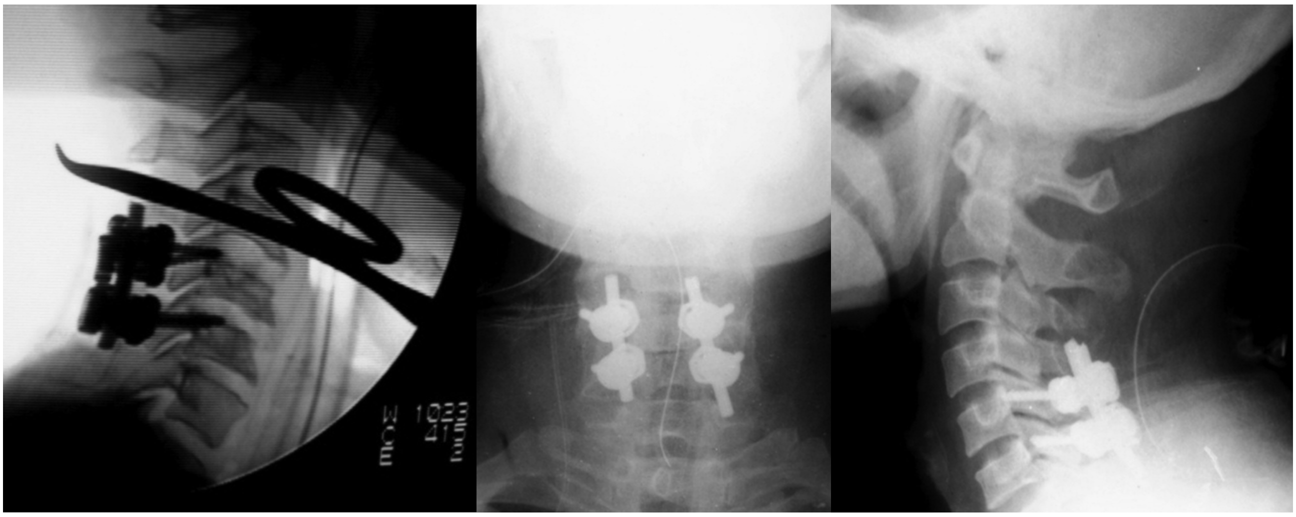


Fig 5: Case of C5-C6 subluxation fixed with Lateral mass screw technique (intraoperative and post-operative radiographs).

Fig 6: Case of C5-C6 subluxation treated by Hartshill rectangle technique with sublaminar wires.

anterior wedges, the lateral mass screw technique can also be used in cases of vertebral body tear drop fractures where the anterior column is partially disrupted and required a better and rigid stabilisation [7,12,13]. The lateral mass screw technique can also be used in fractures where facet dislocation is accompanied by lamina fractures [14]. The Hartshill technique cannot be used in laminar disruptions as it requires fixation of sub-laminar wires to hold the rectangle in place. Thus, intact lamina is required, although an exception is noted in a study by Cooper *et al.* [15] where transpinous wires were passed to stabilise cases in which there is laminar deficiency (Figure 5).

Regarding intra- and postoperative complications, there is strong evidence in literature that the lateral mass screw technique is associated with complications such as vertebral artery injury [7,12,16], postoperative radiculopathy [17], iatrogenic nerve root damage [18,19], screw pull-out [20], and screw loosening[13,15]. However, there are also reports stating that the lateral mass technique is the safest and most effective method available today and the rate of complication should approach zero. For instance Wang *et al.* [21] stated that the lateral mass screw technique was almost free of complications if executed properly. Jeannerret *et al.* [22] also reported that this technique was far superior, more stable and resulted in fewer complications compared to sub-laminar wiring. Nazarian and Louis *et al.* [16] obtained rigid stabilisation with excellent maintenance of alignment and fusion rates with this technique. Hwang *et al.* [23] stated clearly that posterior cervical stabilisation with a poly-axial screw-rod system is a safe and reliable technique. Pateder *et al.* [24] described the use of lateral mass screws for traumatic injuries of the cervical spine as associated with excellent maintenance of alignment and minimal complications. Sekhon *et al.* [20] in a large consecutive case lateral mass screw fixation study stated that lateral mass screw fixation is a safe and effective stabilisation technique and that the risk of vertebral artery/nerve root injury should approach zero. Our study was in agreement with the above authors [16,20-24] as we did not have any intra- or postoperative complications in the present study.

The Hartshill technique which consists of the Hartshill rectangle fixed to the spine with sublaminar wires has been used for posterior stabilisation and fusion. It provides excellent fusion rates in the hands of many surgeons but has its own set of complications. Dove *et al.* [25] stated that the complication of any posterior wiring technique relates mostly to wire breakage or dislodgement. Soft bone in patients as seen in osteoporosis or metabolic bone disease can also lead to wire pullout. The wires may slip and there may be loss of reduction/fixation because there is less rotational stability. Wire breakage is a distressing complication and it occurs because of inadequate external immobilisation or failure to use wires of sufficient diameter. Geremia *et al.* [26] reported that use of the Hartshill rectangle comes with risk of injury to the sub-axial cervical cord, due to the sub laminar wiring technique used for fixation of the rectangle (there is anatomical narrowing of the cervical cord in the subaxial region). Lee *et al.* [27] in a study of 162 patients, documented complications such as residual kyphosis, translational deformity and hyperlordotic deformity. Ward *et al.* [28] conducted a retrospective study of 43 patients and stated that persistent pain, broken implants and worsening kyphosis were the most frequently occurring complications. Although, use of the Hartshill is not a technically challenging procedure, if the system is to be used, it must be used correctly. Failure to correctly apply the rectangle and use bone grafting will lead to an unacceptably high rate of failure.

In the present study, three patients (15%) who underwent the Hartshill technique suffered iatrogenic dural tears which were sutured intraoperatively. One of these patients showed resultant worsened neurological deficit with deterioration of ASIA scale scores from Category D To Category A.

Postoperatively, 10% of patients in each group had superficial postoperative wound infection which gradually healed after targeted antibiotics following wound culture and sensitivity. By the 3-year follow-up of the Hartshill patients operated, there was one case (5%) of wire breakage with no consequent complications. The patient did not have any other complaints (paraesthesias, worsening neurological deficit, or wire impingement on skin) that warranted implant removal. Fusion was well established and evident in these cases. There were no cases of wire migration.

On close follow-up of patients from both groups, there were no cases of loss of alignment (residual kyphosis) or persistent pain. However, there were six patients (30%) in the Hartshill group who had persistent neck disability on follow-up (four had mild disability and two others had moderate disability).

According to the literature, the lateral mass screw technique results in an inherently stable implant which provides immediate rigid fixation. Roy-Camille *et al.* [12] and Cooper *et al.* [16] reported that complex orthosis was not needed post-operatively for this technique. A hard cervical collar can be given to an ambulatory patient for 4-6 weeks or the need for a brace can totally be eliminated. The operating surgeon should make this decision based on the intraoperative stability of the implant. In contrast, postoperatively, all Hartshill technique patients required immobilisation with a Philadelphia Brace for 6-8 weeks. For lateral mass screw fixation, we used a hard cervical collar for four weeks in three patients and a Philadelphia collar in 1 patient).

The lateral mass technique is a technically demanding procedure requiring intraoperative use of an image-intensifier as all screws had to be inserted under C-arm guidance (with an average exposure of 92.5fsec). Thus, radiation exposure is significantly higher in this procedure compared with Hartshill technique which did not require such exposure.

Fusion rates for lateral mass fixation and Hartshill technique have been extensively studied and reported. The largest series for lateral mass technique from Roy-Camille *et al.* [12] who reported 85% of the patients achieved posterior stabilisation. A 100% fusion rate was documented by Nazarian and Louis *et al* [16], Jeanneret *et al* [22], Magerl *et al* [7], Anderson *et al.* [13] and Graham *et al.* [19] for the lateral technique. A 95–99% fusion rate was reported by Cooper *et al.* [15] the lateral mass fixation technique. For the Hartshill technique, Dove *et al.* [25], Geremia *et al.* [26] and Lee *et al.* [27] reported a 100% fusion rate, as we found in the present study.

We conclude that the lateral mass screw technique is relatively better than the Hartshill technique. The lateral mass technique has been successful in expanding the types of cervical spine fractures that can be treated solely by a posterior approach. It is advantageous in fixation of vertebral body tear drop fractures (compression-flexion type-3) and fractures that involve the lamina. Its indication also extends to cervical spines where laminectomy has already been performed. Intraoperatively, there is a very low probability of complications such as vertebral artery injury and dural tears. Consequentially, chances of worsening of neurological deficit are almost zero. Postoperative radiculopathy is rare with this technique. On follow-up, patients in the lateral mass group rarely showed residual kyphosis, persistent pain or screw pullout.

In contrast to the above findings, the Hartshill patients encompass a narrow spectrum of treatable cervical spine fractures (although modifications in the technique can overcome this drawback) and have slightly more intra- and postoperative complications. However, we report a 100% fusion rate for this group. Further, this technique does not require fluoroscopy for placement, and it is not a technically demanding procedure unlike the lateral mass technique which has a steep learning curve. Also, the complications are still manageable and probably surgeon-related. Complications from the Hartshill technique such as dural tears and consequential neurological deficit are not due to the implant itself, but result from difficulties in technical skills. Wire breakage is an inherent complication of all posterior wiring techniques but has been reported when thinner wires (1.0mm diameter) are used. We used the 1.5-2.0 mm diameter wires in all our patients. Lastly, it is an ideal implant for outlying hospitals in a country like India with a vast population and poor infrastructure where it can be used on an emergency basis without image intensifier availability and where cost is a constraint for many patients.

The major limitation of our study was the relatively small sample size of 40 patients. A large multicentre trial with an extensive population base is needed to draw firm conclusions.

CONCLUSION

Lateral mass screw fixation technique is more biomechanically stable than the Hartshill rectangle technique, and has excellent results in terms of patient tolerance, postoperative fusion, early mobilisation and functional outcomes for sub-axial posteriorly stabilised cervical spine fractures. However, fixation with the age-old Hartshill rectangle cannot be designated as a condemned modality, as in certain practical situations (especially in areas where expertise and facilities are limited) its use is common and appropriate.

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