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HARTSHILL FIXATION SYSTEM OR PEDICLE SCREW FIXATION SYSTEM? - A RETROSPECTIVE COMPARATIVE STUDY OF POSTERIOR SPINAL FIXATION METHODS

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ABSTRACT

Spine injuries is a serious medical condition that has a major impact on the quality of life of the patient. Although there is a varying consensus among treating physicians, surgical fixation of a traumatic fracture of the thoracic or lumbar spine is considered necessary if axial and rotational stability is severely impaired or if a neurologic deficit is present or imminent. Considerable controversy exists regarding the clinical performance of different instrumentation systems for the surgical treatment of unstable fractures of the thoracolumbar spine. Although the biomechamical performance of different spinal fixation devices has been studied extensively in the laboratory, comparative clinical outcome data are few. This paper compares the different posterior internal fixation devices. Hartshill (based on sublaminar wiring to gain purchase on posterior column structures alone) and pedicle screw fixation (in which all three spinal columns may be controlled directly and are able to reduce fractures of these columns by ligamentotaxis). The aim of this study is to compare the efficacy of the Hartshill system and newer pedicle screw rod systems. Case records of 30 patients of thoracolumbar spine fractures with incomplete neurological deficit who were operated for decompression and posterior spinal fixation were included in this study. They were divided in two groups of 15 each, Group 1 (Hartshill fixation) and group 2 (Pedicle screw fixation). Analysis of the case records was done for comparison of the two systems with respect to the operative time, blood loss, complications, loss of correction and mobility status at follow up in the treatment of thoracolumbar spine fractures.

INTRODUCTION

Spinal instrumentation is primarily used to immobilize and stabilize the spine till bony fusion takes place. The secondary function is prevention of spinal deformity and alleviation of pain. The common diseases in which these are used are spine trauma, degenerative disease, infections like Pott's spine, tumors and congenital anomalies. Spine injuries is a serious medical condition that has a major impact on the quality of life of the patient. Although there is a varying consensus among treating physicians, surgical fixation of a traumatic fracture of the thoracic or lumbar spine is considered necessary if axial and rotational stability is severely impaired or if a neurologic deficit is present or imminent. Short-segment pedicle screw instrumentation is a well described technique to reduce and stabilize thoracic and lumbar spine fractures. It is a relatively easy procedure but can only indirectly reduce a fractured vertebral body, and the means of augmenting the anterior column are limited. Hardware failure and a loss of reduction are recognized complications Considerable controversy exists regarding the clinical performance of different instrumentation systems for the surgical treatment of unstable fractures of the thoracolumbar spine. Although the biomechamical performance of different spinal fixation devices has been studied extensively in the laboratory, comparative clinical outcome data are few. This paper compares the different posterior internal fixation devices.
Hartshill (based on sublaminar wiring to gain purchase on posterior column structures alone) and pedicle screw fixation (in which all three spinal columns may be controlled directly and are able to reduce fractures of these columns by ligamentotaxis).

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Aim

The aim of this study is to compare the efficacy of the Hartshill system and newer pedicle screw rod systems with respect to the operative time, blood loss, complications, loss of correction and mobility status at follow up in the treatment of thoracolumbar spine fractures.

MATERIALS AND METHODS

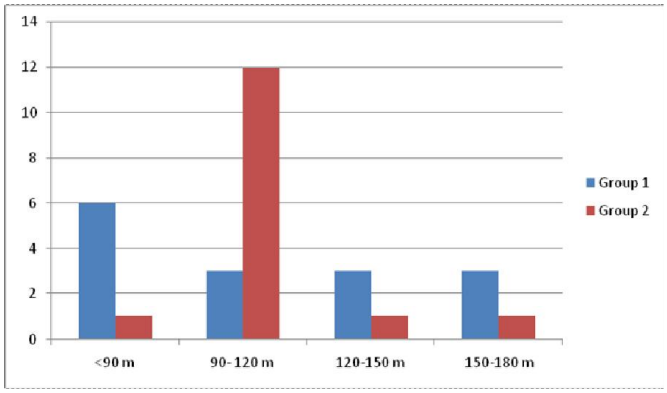
Case records of 30 patients of thoracolumbar spine fractures with incomplete neurological deficit who were operated for decompression and posterior spinal fixation were included in this study. They were divided in two groups of 15 each, Group 1 (Hartshill fixation) and group 2 (Pedicle screw fixation). The Hartshill system- The rectangle is formed from a 3/16 in stainless steel rod and incorporates a roof that allows it to fit snugly against the lamina and provides good rotational stability. The rectangle is secured to the spine by means of doubled 0.91-mm-diameter stainless steel wires. The pedicle screw system- which is sometimes used as an adjunct to spinal fusion surgery, provides a means of gripping a spinal segment. The screws themselves do not fixate the spinal segment, but act as firm anchor points that can then be connected with a rod. The screws are placed at two or three consecutive spine segments and then a short rod is used to connect the screws this construct prevents motion at the segments that are being fused. Comparison of the operative time, blood loss, complications, loss of correction and mobility status at follow up was done.

Physiology of weight transfer in the spine- Dennis has classified the vertebral column into three parts, anterior, middle and posterior. The anterior part constitutes of the anterior half of the vertebral bodies with the anterior half intervertebral discs, the middle consists of the posterior half of the vertebral bodies with the posterior half intervertebral discs and the posterior consists of the pedicles, laminae and the processes alongwith the attached soft tissues. Instability is defined by break of two or more parts. Any implant when used to maintain the alignment of the destroyed columns will fare better in preventing collapse, that is loss of correction, changing the Cobbs angle if it takes purchase in all the three parts (like a pedicular screw system in the present study) rather than in only one part (like the Hartshill system in this study). Moreover the curves of the spine also play an important role in this. The compression force in the lower thoracic and lumbar regions is transmitted through two parallel columns, one anterior (formed by bodies and intervertebral discs) and one posterior (formed by successive articulations of laminae with each other at their articular facets). This study suggests that a considerable part of the weight of the upper limbs and the thoracic cage is transmitted through the ribs to the posterior column (laminae) through the costo-transverse articulations and ligaments. Because of the inclined position of the fifth lumbar vertebra, a significant part of the compressive force from the body is transmitted to the laminae in spite of the anterior inclination of the pedicles at this level. Because of the anterior concavity of the spine in the thoracic region, weight is transferred from the posterior to the anterior column through the inclined pedicles and in the lumbar region, where the concavity is posterior, a part of the compressive force of the anterior column is transmitted to the posterior. Thus, the compressive force in the curvilinear thoracolumbar column tends to deviate towards the line of gravity.

RESULTS

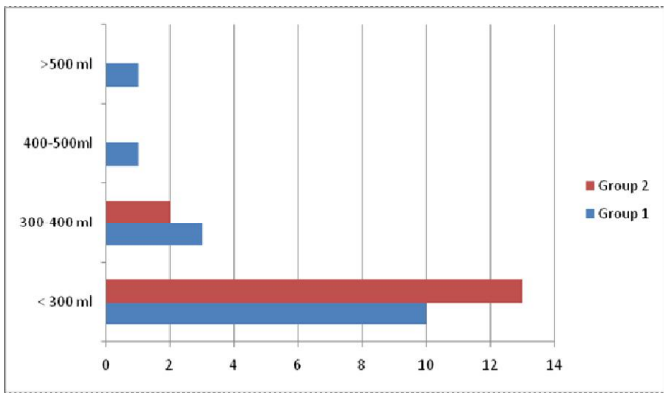
Careful analysis of the case records of the patients in both the groups showed that most of the case in group 1 took less than 90 minutes while in the group 2 took 90 to 120 minutes. Blood loss was less in group 2 whereas the two intraoperative complications of dural tear was in the group 1, postoperative complications were comparable in both the groups. As expected, the loss of reduction (as measured by the change in Kobb's angle) was more in group 1 while the mobility status in both the groups were comparable.

Time (minutes)	Hartshill	Pedicle Screw
<90	6	1
90 – 120	3	12
120-150	3	1
150-180	3	1
Total	15	25



Operative time (minutes)

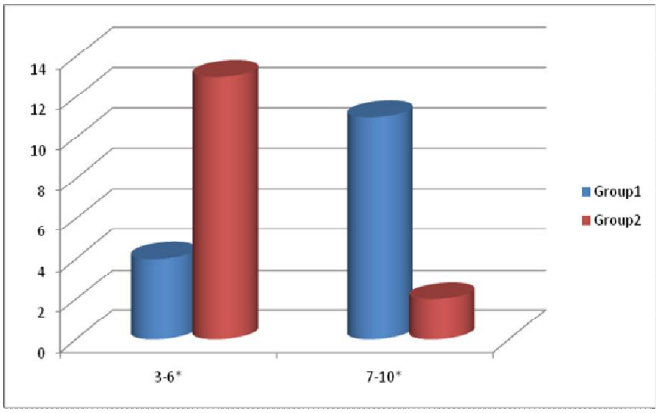
Blood Loss (ml)	Hartshill	Pedicle Screw
< 300	10	13
300-400	3	2
400-500	1	0
>500	1	0
Total	15	15



Blood loss (ml) Postoperative complications

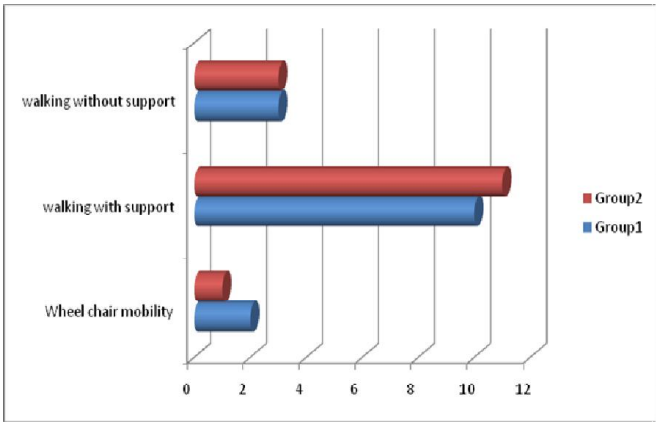
Complications	Hartshill	Pedicle Screw
Infection	1	1
Bed sore	2	2
UTI/chest infection	0	0
Implant breakage	2	2
Prominent implant	1	1
Total	5	5

Follow up Loss of correction (degrees)	Hartshill	Pedicle Screw
3-6	4	13
7-10	11	2
Total	15	15



Loss of correction (Degrees)

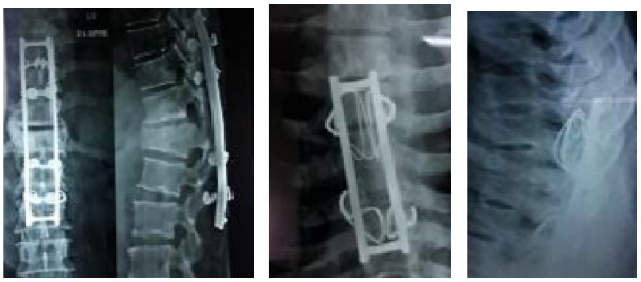
Mobility Status	Hartshill	Pedicle Screw
Wheel chair mobility	2	1
Walk with support	10	11
Walk without support	3	3
Total	15	15



Mobility status

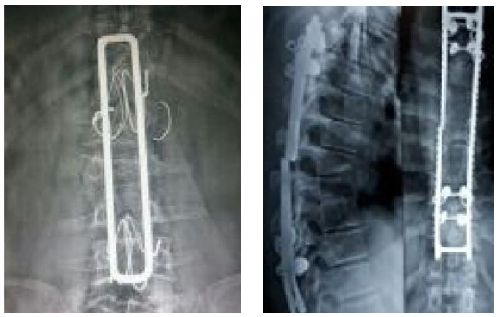
Most of the Initial restoration of anterior vertebral height of fractured vertebrae is much better with pedicle screw systems when compare to Hartshill systems. At follow up too, the loss of reduction was much higher with Hartshill system. There was one case of deep infection necessitating implant removal in the Hartshill group. Two patients showed neurological worsening postoperatively in the Pedicle screw group, both of which recovered subsequently to the preoperative level.

Xrays and clinical photographs



Case 1. **Case 2.**

Case 3.



Broken Implant 1. **Broken Implant 2.**

Implant Prominence **Infection**

Conclusion and Discussion

The advantage of pedicle screws is its capability of holding all the 3 columns of spine where as Hartshill systems get a purchase over the posterior column structures alone. Whether combining an anterior procedure is necessary, is beyond the scope of this study. Vornanen *et al* have shown better reduction with Hartshill rods when compared to pedicle screw systems.

It is important to take into consideration the results of Shono *et al* who have shown in their experimental study that posterior distractive reduction maneuver generates anterior and middle spinal column defects, leading to significant mechanical instabilities particularly in axial compressive loading. Pedicle screw fracture occurres in less than 10% patients according to published literature . Wire breakage with Hartshill instrumentation was reported to be about 10% in reports. Pedicle or lamina fracture varied between 1.4% to 2.6% with the different instrumentation's according to the reports in literature. Neurological improvement has not been shown to be affected by the type of instrumentation used. Transpedicular spongiosaplasty, in which autologous bone grafts are impacted in the vertebral body through the pedicles after reduction to increase the stiffness of the anterior column, was developed and promoted by Daniaux in 1986 as an interesting addition to posterior surgery. Recent studies have shown that this technique does not prevent the recurrence of kyphosis reliably and reproducibly. It has been noted by several authors that the loss of reduction after treatment of a fracture takes place mainly in the disc space. Previous studies suggest that intrusion of the disc through the fractured endplate into the weakened vertebral body, instead of degenerative disc changes, is the likely cause of this collapse Preventing the disc intrusion by restoring the endplate anatomy after fracture reduction and fixation and filling of the resulting bone defect was the subject of a recent cadaveric study It was concluded in one of the studies by Verlaan *et al.* that anterior column augmentation by transpedicular balloon vertebroplasty with calcium phosphate cement (CPC) injection was safe and feasible. Several studies have been conducted to assess the strength and stiffness of vertebral compression fractures after vertebroplasty with polymethyl methacrylate cement and CPC. In the cadaveric biomechanical study by Mermelstein *et al*. they found that the injection of CPC in a burst fracture reduced the load on the pedicle screw construct that was inserted for fracture stabilization. It was concluded by them that vertebroplasty with CPC after posterior instrumentation might reduce hardware failure and anterior column collapse and decrease the need for a secondary anterior approach. As proposed by some authors that the fractured and impressed endplate increases the chance of intrusion of the intervertebral disc in the corpus which can cause subsequent spine deformity. The possibilities of vertebroplasty to reduce the endplate impression are limited and can only be achieved by building pressure on the cement, which is strongly associated with an increase in cement leakage that can result in spinal cord compression and pulmonary embolism. The use of inflatable bone tamps in the treatment of osteoporotic compression fractures has received a lot of attention the last few years. In one of the cadaveric studies, it has been demonstrated to be feasible and safe to reduce the endplate in burst fractures after pedicle screw stabilization.

We conclude that in our country where resources are limited, using the easier and the less demanding posterior approach, and indirect reduction techniques are the best surgical options for injuries of T 12 and L 1. The newer pedicle screw rod system are more versatile and technically superior to classic Hart shill systems, in fixation of thoraco lumbar spine injuries because pedicle screw rod systems achieve 3 column fixation causing efficient distraction and translation and because of their ability to maintain the reduction at follow up. At the same time we emphasize the fact that insertion of pedicle screws needs technical expertise and experience of high order to minimize complications of nerve root injury and pedicle fracture.

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