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EVALUATION OF BREACH RATE WITH IMAGE AND K WIRE ASSISTED PEDICLE SCREW INSERTION TECHNIQUE IN THORACIC & LUMBAR SPINE

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ABSTRACT Pedicle screw fixation nowadays is the mainstay of spinal fixation indicated for traumatic thoracolumbar fracture , Potts spine , degenerative spondylolisthesis and tumour excision surgery. After that Image assisted technique with high frequency C Arm intensifier is used but shooting for each pedicle to insert pedicle screw is associated with excessive exposure of cumulative radiation in long run. This was a prospective observational study done in the department of orthopaedics , NSCB Medical college Jabalpur over a period of 2 year after the approval by the Institutional Ethical Committee. Spine Fixation from D 6 to S1 vertebrae were included in the study. We included 40 consecutive patients in which pedicle screw fixation was done in thoracic and lumbar spine in which, 23 were males and 17 were females. The distribution of patients included 28 traumatic thoracic and lumbar fracture, 7 patients with lumbar spondylolisthesis , 4 patients with Potts spine and one patient with L5 plamacytoma excision. Traumatic vertebral body fracture resulted from fall from height in 16 patients and from road side accident in 13 patients . Maximum patients were in 20-40 years age group (65%).A total of 294 pedicle screws were inserted. .The consultant placed 149 pedicles and the orthopaedic resident doctor placed 145 pedicle screws . All pedicle screw were placed with the help of k wire postion in relation to the pedicle with limited use of C arm image. Postoperatively CT scan was done to evaluate any cortical breach in pedicle or vertebral body. Consultant trained in spine Surgery inserted pedicles on left side and Orthopaedic resident inserted pedicle screws right side under supervision . : Out of 149 pedicles , consultant placed 114 pedicles (76.5 %) without any breach while orthopaedic resident doctor placed 49 pedicles out of 145 (33.39 %) without any breach. Total number of medial breach on CT in the consultant group and resident group were 2.68 % and 24.8 % respectively out of them total number of significant medial breach(more than 2 mm) in the consultant and resident group were 0.67% and 4.82% respectively. Total number of lateral breach on CT in the consultant group and resident group were 20.8 % and 38.6 % respectively while total number of significant lateral breach(more than 2 mm) in the consultant and resident group were 2.68 % and 8.27 %. There were no clinical morbidity associated significant cortical breach in both consultant and resident group. The mean medial and lateral breach was found to be statistically insignificant for consultant as well as resident group. P value obtained by Chi squre test was 0.512 for the consultant group and 0.929 for the resident group. Number of shoots of image intensifier were less than 10 in 87.5% of cases. We concluded that under appropriate supervision, orthopaedic resident is able to place pedicle screws safely with an acceptable breach rate, reduced time and reduced radiation under X ray guidance of C arm Image.

KEYWORDS : Pedicle screw fixation, Pedicle screw breach, Radiation exposure

INTRODUCTION

Pedicle screw fixation nowadays is the mainstay of spinal fixation indicated for traumatic thoracolumbar fracture , Potts spine , degenerative spondylolisthesis and tumour excision surgery. Pedicle screws have various biomechanical advantages but screw malposition can be devastating when it occurs in the proximity of neurovascular and visceral structure. Gradually the expert started the technique with free hand technique, image assisted technique and navigation . Placement of the pedicle screws in a free –hand technique depends upon tactile palpation with consideration of anatomic landmark like lateral border of pars interarticularis, transverse process and facet joint and majority of expert surgeon are doing it with success but during training residents require long learning curve not to do this even under supervision as there is anatomic change of position of vertebrae during surgery.[1]

After that Image assisted technique with high frequency C Arm intensifier is used but shooting for each pedicle to insert pedicle screw is associated with excessive exposure of cumulative radiation in long run.. Although navigation assisted pedicle screw fixation has drastically reduced the radiation exposure but it is still not available in many center due to its high cost . [2]

In thoracic spine , even expert surgeon has pedicle cortical breach up to 41% and even medial breach in 23 % of screws.[3] But all the breaches may not cause clinically significant complication.[4]Later with the help of fluoroscopy , breach rate was reduced to 10-20 % range.[5]But it has increased the operative time with radiation exposure.[6] In our study , we combined the k wire position and image assistance and we put the pedicle screw after analyzing the position of K wire in relation to the pedicle to counteract the anatomic variations due to positioning of the patients during surgery.

To our knowledge there is no clinical report demonstrating pedicle breach rate comparison between consultant and orthopaedic resident.

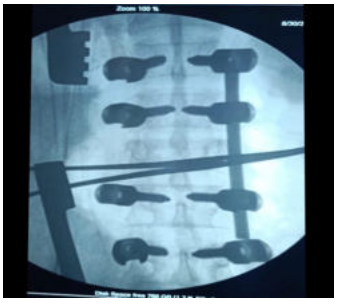
MATERIALS AND METHODS:

This was a prospective observational study done in the department of orthopaedics , NSCB Medical college Jabalpur over a period of 2 year after the approval by the Institutional Ethical Committee. Spine Fixation from D 6 to S1 vertebrae were included in the study. We included 40 consecutive patients in which pedicle screw fixation was done in thoracic and lumbar spine in which, 23 were males and 17 were females. The distribution of patients included 28 traumatic thoracic and lumbar fracture, 7 patients with lumbar spondylolisthesis , 4 patients with Potts spine and one patient with L5 plamacytoma excision. Traumatic vertebral body fracture resulted from fall from height in 16 patients and from road side accident in 13 patients . Maximum patients were in 20-40 years age group (65%).A total of 294 pedicle screws were inserted. .The consultant placed 149 pedicles and the orthopaedic resident doctor placed 145 pedicle screws . All pedicle screw were placed with the help of k wire postion in relation to the pedicle with limited use of C arm image. Postoperatively CT scan was done to evaluate any cortical breach in pedicle or vertebral body. Consultant trained in spine Surgery inserted pedicles on left side and Orthopaedic resident inserted pedicle screws right side under supervision . Orthopaedic resident who, prior to study, had no experience at all with thoracic and lumbar pedicle screw placement. Posterior midline exposure was done after the confirmation of the level of instrumented vertebra and Carm foot were marked with sticking to avoid unnecessary shoots. After Exposure, anatomical bony landmarks like the lateral border of pars interarticularis, transverse process and superior and inferior facets joint were identified and provisional k wires were inserted about 1cm depth with free hand to the proposed pedicles to be inserted and then posteroanterior and lateral Carm shoot were taken . After that both the image were analysed in respect of angulation (superoinferior or mediolateral) and position of k wire in the pedicle. The provisional entry point in lower thoracic spine was followed just lateral and caudal to the intersection of the mid portion of the facet joint and the superior edge of the transverse process. The provisional entry point in Lumbar vertebrae was defined as the confluence of any four lines mid transverse process, mid facet ,

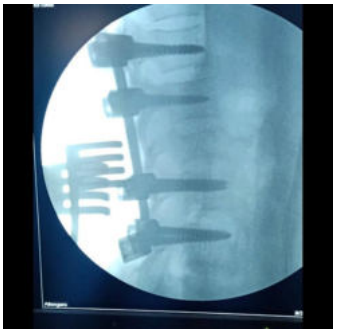
mamillary process and pars interarticularis .Based on the analysis of position and angulation of k wires in coronal and saggital view , pilot hole was widened with awl in analysed direction .Then the straight pedicle probes was put with light hammer and after that pedicle hole was palpated with a ball tipped probe and then hole was tapped 1 mm smaller than the proposed screw diameter (5.5 mm) .

Carm was used in case of doubt in any pedicle screw in between also. Postoperative thin cut CT scan was done for thoracic and lumbar spine to analyze cortical pedicle and vertebral body breach. We evaluated on axial image for any medial or lateral pedicle breach or anterior vertebral body breach and Saggital image for superior or inferior pedicle breach for pedicle screw and anterolateral perforation of the vertebral body. Cortical breach were quantified in millimeters and graded with no breach (grade 0), 0–2 mm (grade 1) breach, 2–4 mm (grade 2) breach, or greater than 4 mm (grade 3) breach .Cortical breach more than 2 mm was considered as the significant breach. Chi square test was used to check percentage of significant pedicle breach .P < 0.05 was considered to be significant.

POSTEROANTERIOR VIEW OF C –ARM SHOOT SHOWED K WIRE



POSTEROANTERIOR VIEW SHOWED PEDICLE SCREWS



LATERAL VIEW SHOWED PEDICLE SCREWS

LATERAL VIEW OF C –ARM SHOOT SHOWED K WIRE

INTRAOPERATIVE K WIRE POSITION

RESULT:

Out of 149 pedicles , consultant placed 114 pedicles (76.5 %) without any breach while orthopaedic resident doctor placed 49 pedicles out of 145 (33.39 %) without any breach. Total number of medial breach on CT in the consultant group and resident group were 2.68 % and 24.8 % respectively out of them total number of significant medial breach(more than 2 mm) in the consultant and resident group were 0.67% and 4.82% respectively. Total number of lateral breach on CT in the consultant group and resident group were 20.8 % and 38.6 % respectively while total number of significant lateral breach(more than 2 mm) in the consultant and resident group were 2.68 % and 8.27 %. There were no clinical morbidity associated significant cortical breach in both consultant and resident group. The mean medial and lateral breach was found to be statistically insignificant for consultant as well as resident group. P value obtained by Chi squre test was 0.512 for the consultant group and 0.929 for the resident group .The mean distance of pedicle breach in consultant was 0.1085+_0.14 and in resident it was 0.66+_ 0.21. Mean grade of pedicle screw breach in consultant 0.15+_0.028 and in resident it was 0.65+_0.21 . Lateral breach was more than the medial breach in the both consultant and resident group in thoracic and lumbar spine .Number of shoots of image intensifier were less than 10 in 87.5% of cases. In our study only 2 pedicle breached the anterior cortex in resident group which were present in D12 and L1 level. Both were grade 1 and not associated with any clinical complication. Only one pedicle involved in superior wall breach which is belongs in D11 level and also not associated with any clinical morbidity. Our study had shown that mean duration of surgery was 180.77 min with mean blood loss was 330.66 ml.

Table 1 showed Pedicle breach rate in number in Consultant and Orthopaedic resident group

	CONSULTANT (149 pedicle)		ORTHOPAEDIC RESIDENT (145 pedicle)	
	Medial	Lateral	Medial	Lateral
Total number of breach on CT	4 (2.68 %)	31 (20.8%)	36 (24.8%)	56 (38.6%)
Total Number of significant breach on CT	1 (0.67%)	4 (2.68%)	7 (4.82 %)	12 (8.27 %)
Pedicle with no breach	114 (76.5%)		49 (33.79 %)	
Chi square test	0.423		0.007	
P values	0.512		0.929	

Table 2 showed pedicle breach rate in MM in consultant and Orthopaedic resident group

	CONSULTANT		ORTHOPAEDIC RESIDENT	
	MEDIAL	LATERAL	MEDIAL	LATERAL
0-2MM	3(2.03%)	27(18.1%)	29(20%)	44(30.34)
2-4MM	1(0.67%)	4(2.68%)	7(4.82%)	12(8.27%)
MORE THAN 4 MM	0(0%)	0(0%)	0(0%)	0(0%)

Table 3 showed pedicle breach rate in Thoracic and lumbar spine

	CONSULTANT		ORTHOPAEDIC RESIDENT	
Grade	Medial	Lateral	Medial	Lateral
0-2 mm (grade 1)	Thoracic 3	Thoracic 12	Thoracic 13	Thoracic 16
	Lumbar 0	Lumbar 15	Lumbar 16	Lumbar 28

2-4 mm (grade 2)	Thoracic 1	Thoracic 3	Thoracic 5	Thoracic 5
	Lumbar 0	Lumbar 1	Lumbar 2	Lumbar 7
More than 4 mm (grade 3)	0	0	0	0

DISCUSSION:

Spinal canal is not violated if a pedicle screw is completely contained within the pedicle. But Voccaro et al in his cadevaric study showed 23 % medial cortical breach with entry in spinal canal. The incidence of neurovascular injury or screw revision noticed in less than 2% of patients.[7,8] Image guidance in many studies cortical breach reduced to less than 10% [9,10]

In our study total medial breach was 2.68 % in the consultant group and it was 24.8 % in the resident group but significant medial breach was reduced to the 0.67 % for the consultant group and 4.82 % in the resident group.

Laine T et al noticed increases in screw insertion time by as much as 50% at each level with the use of image guidance.[11] In our study , Posteroanterior and lateral C arm Shoot with Xray guidance reduced the time of insertion of pedicle because we analysed the both the image and put the pedicle screws.

Currently used Navigation to pedicle screw is costly and out of reach to many spine center and it also has potential risk of registration error due to change of intervertebral anatomic relationship during surgery.[12]Medial cortical breach more than 4 mm can cause neurological complications . [13] In our study , image with Xray guidance obviated the need of multiple Carm shoots and it prevented the changing anatomic variation of patients positioning on the operating table. Majority of the pedicle screw were grade 0 (no breach) and grade 1(0-2 mm). Wang et al. (2010)13 did a study on freehand thoracic pedicle screws placed by neurosurgery residents. On CT analysis, they were found to have 6% of medial cortical violation while 8.9% of lateral cortical violation. In our study, the orthopedic resident had a rate of 4.82 % significant medial and 8.27 % significant lateral violation[14] Carbone et al noticed 2.4 % medial pedicle breach and 10.3 % lateral pedicle breach in his fluoroscopically assisted technique of thoracic pedicle screw insertion in unstable thoracic and thoracolumbar injuries. [15] Agrawal et al in his cadaveric study of total 260 pedicle screws insertion in thoracolumbar vertebra by surgeon and resident (130 screws each) which were divided equally by freehand and image- assisted technique . Significant medial breach occurred with free hand technique (7.69% by resident ,6.15% by expert surgeon) and image assisted technique (3.07 % by resident and expert surgeon both) . Significant lateral breach occurred with free hand technique (10.76% by resident ,1.53 % by expert surgeon) and image assisted technique (9.23 % by resident and 6.15 % expert surgeon) on CT evaluation.[16]

The acceptable degree of medial and lateral pedicle breach is still controversial as it has varied in different studies. Gertzbein and Robbins (1990) believed that “safe zone” of allowable medial encroachment was 4 mm in relation to the intradural contents. They found that a CT myelogram postoperatively demonstrated 2 mm of the epidural space with 2 mm of subarachnoid space from T10 to L4. They reported that 81% of screws were placed within 2 mm of medial border of pedicle and 6% had 4–8 mm of canal encroachment, out of which 2 of their patients developed temporary neurological complications.[17] In another study, Belmont et al. (2002) are of the opinion that acceptable limits were 2 mm for medial wall penetration and 6 mm for lateral wall penetration.[18] Rampersaud et al in its study in cadevaric model showed average fluoroscopic exposure time (9.3 second /Screw) and average number of fluoroscopic image (8.5/ screw).[3]

In our study , number of C arm shoots were reduced less than 10 shoots in more than 87.5 percent of cases because we put the screw with analysing the position of Kwire in posteroanterior and lateral Carm shoot and by marking the foot of Carm Image to avoid unnecessary shoots.

Upendra et al gave the concept to differentiate between acceptable (benign marginal misplacement) and unacceptable (dangerously placed). [19]

In our study almost all of the pedicles were in the acceptable categories and lateral breach was more than the medial breach in thoracic and lumbar spine in both groups.

CONCLUSION:

We concluded that under appropriate supervision, orthopaedic resident is able to place pedicle screws safely with an acceptable breach rate, reduced time and reduced radiation under X ray guidance of C arm Image.

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