Research Article

Assessment of pedicle screws inserted free hand in thoracolumbar spine using radiographs and CT scan

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Abstract

Introduction: The pedicle screw instrumentation of thoracolumbar spine has become widely popular. But pedicle screw instrumentation carries with it the potential of neurovascular damage. Traditionally intra operative fluoroscopy and post operative radiographs have been used to assess the placement of pedicle screws. With the advent of CT scan the accuracy of assessment improved and it became known that the radiographic assessment may not be always correct. **Material and Methods:** Prospectively 200 pedicle screws inserted in 30 patients operated for various indications were evaluated with post operative radiographs and CT scan. In radiographs attempt was made to detect breach in any direction. Subsequently CT was done to evaluate the position of the screws and the findings were then compared with those noted on radiographs. **Results:** Of the 200 screws 5 were detected to be breaching the pedicle on radiographs, whereas CT evaluation revealed breach of pedicle in 11 pedicle screws. None of the patients had neurological sysmptoms. **Conclusion:** We noted that assessment based on radiographs may not be always correct and CT needs to be done to ascertain the position of the screw when in doubt.

Keywords: pedicle screws, radiographs, CT scan

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INTRODUCTION

Harrington and Tullos first reported the use of pedicle screw in 1969[1]. Pedicle screw instrumentation has become widely accepted and has revolutionized the surgical treatment of spinal disorders. Complications can occur due to misplacement of pedicle screws due to close proximity to spinal canal and adjacent vessels[2]. Pedicle screw misplacement rate has been reported from 0 to 2 to 25 percent in scoliosis patients and about 4.2 percent in degenerative disorders[1]. Conventionally assessment of placement of pedicle screws is done by fluoroscopy intra operatively and by post operative radiographs. But radiographic assessment alone has been reported to be unreliable for evaluating pedicle screw placement[3]. Post operative CT scan has been done to evaluate misplacement of pedicle screws and have been reported to be reliable[3,4]. Also with radiographic assessment considerable difference between observers has been reported[4]. This study was done to evaluate the placement of pedicle screws with radiographs and compare with it the findings on CT evaluation.

MATERIAL AND METHODS

Prospectively 200 pedicle screws inserted in 30 patients operated for various indications at Department of Orthopaedics, Government Medical College and Hospital were included in the study. Screws evaluated, were inserted in thoracolumbar spine mainly lower thoracic and lumbar. All screws were inserted under fluoroscopic control. Liberal incision was taken in each case and exposure done laterally to the transverse process so as to avoid any hindrance in inserting the screw in desired angle. Pilot hole was made with bone awl, pedicle was probed with flat tip probe, pedicle walls checked with a

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ball tip probe, tapped, again checked with a ball tip probe and finally screw inserted. For lumbar region we used the intersection method to determine the entry point. In lower thoracic we used entry point that is along the lateral border of facet at the middle of transverse process going towards upper border as we go up, mid thoracic along the lateral border of facet at the upper border of transverse process and in upper thoracic entry point gradually comes down to middle of transverse process. The length of the screw was determined by sounding the anterior cortex of the vertebral body with the ball tip probe. Titanium 6 mm diameter screws were used in lower thoracic and lumbar region, 5 mm screws were used in mid thoracic and in upper thoracic region 4.5 mm screws were used. Screw position was confirmed with both AP and lateral fluoroscopy. Standard AP and Lateral radiographs were done post operatively and evaluated by two Senior Orthopaedic surgeons. Surgeons assessed the screws as 'in' or 'out'. Single interpretation was obtained with consensus. Computed tomography was then performed. Reformatted images were obtained in axial and sagittal planes to assess the position of screws accurately. Similarly CT were assessed by two independent observers who gave a common conclusion. On CT reporting was done as: screw inside the pedicle, perforation of the pedicle cortex up to 2.0 mm, 2.1 - 4.0 mm, 4.1 - 6.0 mm and screw outside the pedicle. Also the direction of breach was noted. Radiographic assessment was then compared with the results of post operative CT scan.

OBSERVATION AND RESULTS

Out of the 200 pedicle screws inserted 11 were detected to be misplaced on CT evaluation. The pedicle breaches detected were as depicted in Fig 1. All of the lateral breaches were in thoracic region. There was 1 medial breaches in the range of 0-2mm detected on CT. One breach inferior and two superior in the range 0-2 mm were noted. On radiographs out of the 11 breaches only 5 were detected. Five of the lateral breaches were detected on radiographs but rest of the breaches were missed. Although there were no false positives reported on radiographs. There was no post operative neurological complication noted due to misplaced screws. No anterior cortex breaches were noted.

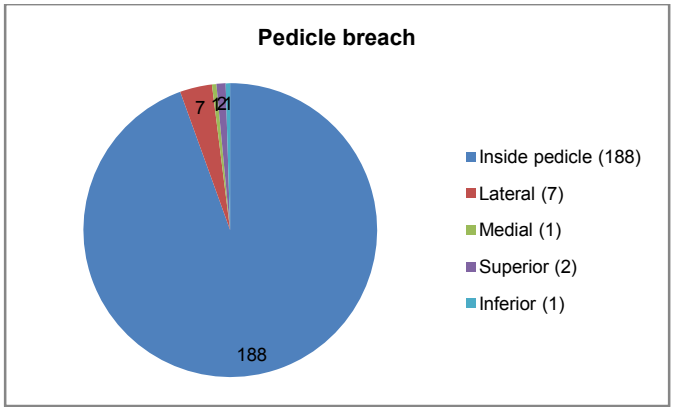

Figure 1: Pedicle breaches

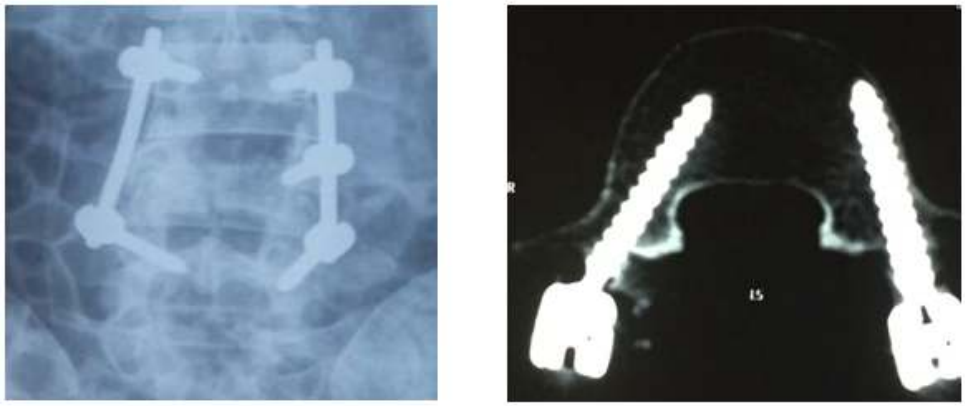

Figure 2: A) X ray of operated L4 burst fracture in which the left pedicle screw in L5 appears to be breaching on lateral side, **B)** But the CT of same patient shows no breach for that screw.

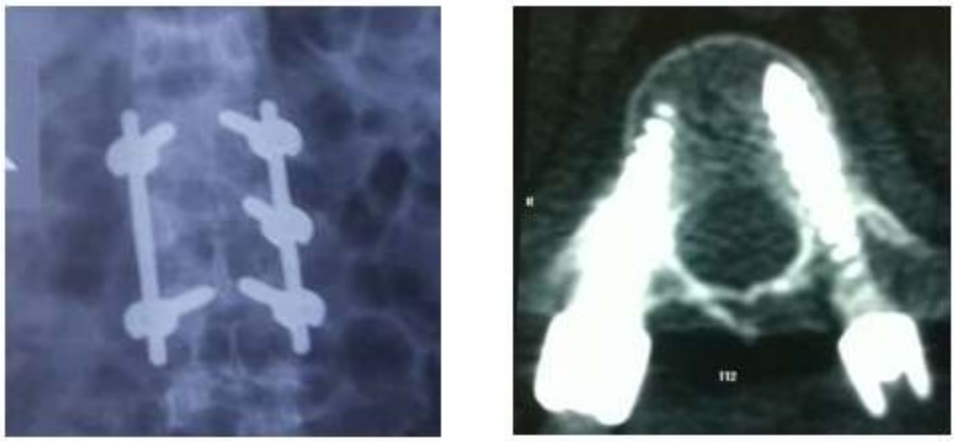

Figure 3: A) X ray of operated L1 fracture, all screws appear OK, **B)** but right screw of T12 has lateral breach on CT

DISCUSSION

Pedicle screw fixation has become a preferred option for spinal fixation as it provides three column fixation, no need for posterior column to be intact and because of strong bone – screw interface permits shorter constructs which lessens the number of motion segments sacrificed[5]. But pedicle screw instrumentation is accompanied with potential risk of complications and incidence of nerve root injury or irritation has been reported in 3.2% of cases[6]. Dural injury has been reported in 7 of 124 patients[7] and in 2 of 89 patients[8] in two series of pedicle screw fixation for the treatment of degenerative spine disease. However it is reported that most misplaced screws do not create nerve root injury[1] or neurologic deficit[6]. Post operative assessment of pedicle screw placement is important for safety and efficacy concerns. Weinstein *et al*[9] reported on reliability and validity of roentgenograms as a technique for evaluating the success of pedicle fixation in cadavers. They reported unacceptable low sensitivity of radiographs for determining screw perforation. Ferrick *et al*[10] reported a cadaveric study regarding reliability of biplanar radiographic evaluation of pedicle screw position. They reported that screws misplaced medially are more likely to be missed on radiographs and that surgeons must not solely rely on radiographs. Farber[11] *et al* evaluated 74 pedicle screws in 16 patients who underwent lumbar spinal fusion with plain radiographs and CT scan. They reported that CT showed 10 times as many screws violating the medial cortex as did plain radiographs, although they did not report neurologic complication. They recommended that plain radiographs and thin section computed tomographic scans should be used to evaluate postoperative neurologic deficits in patients undergoing instrumented lumbar spine fusion with pedicle screws. Learch *et al*[6] reported a systematic approach to improve assessment by radiographs as compared to CT. Although they reported that with their approach they could identify many types of misplaced pedicle screw on radiographs but found improved accuracy of assessment with CT examination. Laine *et al*[12] reported evaluation of 152 pedicle screws. They reported 32 perforations of pedicle cortex of which one tenth were detected on radiographs. They reported no neurological complication with perforation less than 4 mm. Concern about misplaced pedicle screw is not only about neurological complication but also that malpositioned screws reduce the stability of the construct and may cause screw loosening[12]. The breach of pedicle in our series is very less as compared to that reported in literature. Possible reasons of less pedicle breach in our series we feel are: liberal exposure, use of blunt probe directed towards thick medial pedicle wall to probe pedicle, confirmation of pedicle walls with ball tip probe and fluoroscopic confirmation in both AP and lateral views. But our study again reaffirms the fact radiographs are not accurate in assessment of placement of pedicle screws and CT is recommended to accurately assess the position of screws when required.

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