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Early complications of spinal pedicle screw

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Abstract The complications of 648 consecutively inserted Universal AO pedicle screws (140 in the thoracic spine and 508 in the lumbar spine) performed by one surgical team to treat 91 patients with spinal problems, were reviewed. The spinal pathology consisted of: scoliosis (34 patients), degenerative lower lumbar spinal disease (25 patients), neoplastic spinal disease (11 patients), thoracic kyphosis (8 patients), spinal fractures (7 patients), lumbo-sacral spondylolisthesis (3 patients), and osteomyelitis (3 patients). Intraoperative complications were: screw misplacement ($n = 3$), nerve root impingement ($n = 1$), cerebrospinal fluid leak ($n = 2$) and pedicle fracture ($n = 2$). Postoperative complications were; deep wound infection ($n = 4$), screw loosening ($n = 2$) and rod-screw disconnection ($n = 1$). The conclusion was that pedicle screw fixation has an acceptable complication rate and neurological injury during this procedure is unlikely.

Key words Spinal instrumentation · Pedicle screw

Introduction

The aim of this study was to address the safety of using pedicle screws in spinal surgery. The rapid advances in spinal surgery have led to various types of spinal instrumentation. The place of pedicle screws, however, remains controversial [4, 9], in particular the associated complications. Pedicle screws were first described by King in 1944, further development was subsequently undertaken by Roy-Camille and Louis [3, 8].

In contrast to hook systems, pedicle screws are placed at a 90° angle to the spine. Neurological impairment following misplacement of pedicle screws has, therefore, been a major concern [4]. We reviewed the complications of pedicle screw insertion at the Centre for Spinal Studies and Surgery as well as the associated complications.

Materials and methods

A prospective study was carried out between November 1993 and December 1994 on 91 patients with spinal pathology who were surgically treated by one surgical team. The AO Universal Spinal System screw, was used (see Table 1).

The following factors were studied; the operative time spent to introduce a pedicle screw after exposing the site of insertion, intraoperative complications during insertion of the screw and the postoperative complications. The pedicle size and its orientation was studied by checking the preoperative plain radiographs of the spine prior to insertion of the screw. An intraoperative lateral plain radiograph of the spine was performed in all the cases to check the direction of insertion of the screw in relation to the pedicle.

Results

Pre- and postoperative plain radiographs of the spine were seen in an X-ray conference by two radiologists and four senior and ten junior spinal surgeons. Any comments in regard to pedicle screw malpositioning were recorded. In a sample number of cases ($n = 20$) the average time taken to introduce a pedicle screw by an experienced surgeon was 2 min in the lumbar spine and 3 min in the thoracic region. Average follow-up was 18 months. Three immunocompromised patients with spinal metastatic disease, who underwent decompression of the spinal canal

Table 1 Details of 91 cases of spinal pathology, treated with the AO Universal Spine System (*T* thoracic, *L* lumbar)

Indications	No. of patients	Sex	Mean age (years)	Screw site
Degenerative lumbar scoliosis	6	6 F	45	60 L
Idiopathic scoliosis	27	3 M, 24 F	12	45 T, 107 L
Congenital scoliosis	1	1 F	35	4 T, 4 L
Kyphosis (ankylosiing spondylitis)	5	4 M, 1 F	40	20 T, 32 L
Kyphosis (Scheuermann's disease)	2	1 F	27	12 T, 8 L
Paralytic kyphoscoliosis	1	1 F	45	4 T, 6 L
Low-lumbar spondylosis	25	9 M, 16 F	40	174 L
Low-lumbar spondylosis-thesis (II)	3	1 M, 2 F	37	12 L
Metastatic spinal surgery	11	3 M, 8 F	57	31 T, 59 L
Spinal fracture	7	6 M , 1 F	39	24 T, 28 L
Spinal infection	3	1 M, 2 F	40	18 L

and spinal fixation, died as a result of pulmonary dissemination of the cancer. A lateral approach to the pedicle was used in our series (midway between the upper and lower border of transverse process of the vertebra, at its junction to the superior facetal process). The pedicle probe made the approach in the coronal and sagittal direction to the pedicle at each level, a small pedicle feeler was pushed down the hole to ensure that bone was circumferential at each level.

The insertion of pedicle screws was technically difficult in certain pathologies: second-time procedures; the concave side of scoliosis; congenital scoliosis; and spondylolisthetic vertebra.

Complications

Intraoperative complications consisted of:

1. Pedicle fractures (two pedicles in one patient, during correction of a severe deformity of the spine
2. Cerebrospinal fluid leak (two cases), resolved spontaneously
3. Screw misplacement (three cases), one patient had sensory L5 root changes, this settled within 3 weeks

Postoperative complications consisted of:

1. Deep wound infection (five cases). This was the only significant complication (superficial wound infection occurred in five cases, this settled spontaneously with appropriate antibiotics for 5 days). The deep infections followed instrumented spinal fusion following decompression of extradural metastatic carcinoma in immunocompromised patients who had received radio- and chemotherapy concurrently (three patients). In one patient, the infection followed the correction of kyphotic spinal deformity secondary to ankylosing spondylitis. The fifth case was a revision surgery.
2. Screw loosening (two cases). In one case the screw was loose and in the other the loosening was associated with poor bone quality. The screw in both cases was replaced with a larger one. No screw breakage was noted.
3. Screw-rod disconnection due to technical error (one case). This was replaced as well.

Reproducibility

The main author (observer 1) and two senior spinal fellows evaluated 111 pedicle screws from anteroposterior and lateral radiographs (15 patients) on two separate occasions to determine the intra- and inter-observer reliability. The pedicle screws were graded as: grade 1 – definitely in the pedicle; grade 2 – uncertain, possibly not in the pedicle; grade 3 – definitely not in the pedicle. The results of each evaluation are shown in Table 2. The screw that was recorded as definitely not in the pedicle by all of the three observers in both their evaluations was the same screw. There are no significant differences between the first and the second evaluation of the pedicle screws for any of the three observers (Kruskal-Wallis one-way analysis of variance). There are also no significant differences between the observers for either the first or the second evaluation of the pedicle screws ($P > 0.05$, Kruskal-Wallis one-way analysis of variance).

Table 2 Intra- and inter-observer reliability in the radiological assessment of pedicle screw placement (*ev* evaluation)

Grade	Observer 1		Observer 2		Observer 3	
	1st (ev)	2nd (ev)	1st (ev)	2nd (ev)	1st (ev)	2nd (ev)
1	105	107	104	107	107	106
2	5	3	6	3	3	4
3	1	1	1	1	1	1

Discussion

The insertion of pedicle screws has been reported to be associated with a significant complication rate [6, 13]. Complications following pedicle screw fixation include increased operative time with associated increased infection rate and, in particular, neurological problems inherent in the procedure [2, 3].

The most frequent complication is neurological injury. A low incidence of neurological complications was reported by Roy-Camille et al. [8]; Blumenthal and Gill reported a complication rate of 6% (1): whereas in our series the rate of neurological complications was 1.09%, although the rate of significant nerve injury by a screw in 648 cases was 0.15%.

In Sanford and Myers' series incidences of 2.6% superficial and 0.6% deep wound infection were noticed following the use of pedicular fixation of the spine [9]. The incidence of deep wound infection in our series would have been 1% if four immunocompromised patients (three with secondary neoplasia, one with ankylosing spondylitis) had been excluded from the series. Three of these patients were receiving concurrent chemo- and radiotherapy for their malignant diseases.

The percentage of difficult screw placements in our series was 3.3% compared to 8.1% in Sanford and Myers' series [9].

The overall pedicle breakage rate for pedicle screwing for lumbar spinal fusion is 1.1% in the literature; no screw breakage occurred in our series.

There were two cases of cerebrospinal fluid (CSF) leak before insertion of the pedicle screw; these settled and did not require any intervention. In one series of 148 cases of spinal fusion using a posterior spine fixator (PSF), 34 screw loosenings, 9 screw fractures, 13 screw/bolt angulations, 3 disconnections of screw/bolt or rod and 3 rod breakages occurred [7]. In another series, using 297 Steffee pedicle screws with plate fixation, 17 screws broke [4]. Compared to the above two series, the hardware complication rate associated with the Universal Spinal System is much lower (two cases of screw loosening, one case of screw-rod disconnection and three cases of rod breakage in our series).

The overall intra- and postoperative complication rate of pedicle screw instrumentation in our 91-patient series was 13%.

We relied entirely in the current study on plain pre-, per- and postoperative radiographs to identify pedicle screw misplacement. Using CT scans rather than plain radiographs for analysis of the pedicle morphometry has been found to make no significant difference [10–12, 14]. Although CT scans would be more accurate we could not justify the extra expense and radiation for 91 patients. Three cases of pedicle screw misplacement were identified in our series, of which only one case involved temporary sensory deficit. The parameters linked to a satisfactory screw placement include point of entry, angle of insertion of the screw and pedicular isthmus width.

Conclusion

In experienced hands, the pedicle screw system is a safe procedure for treating various diseases of the spine. The rate of hardware complications using the Universal Spinal System is acceptable and lower than that associated with other parallel pedicle screw systems.

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References

1. Blumenthal S, Gill K (1993) Complications of the Wiltse pedicle screw fixation system. Spine 18:1867–1871
2. Frymoyer J (1991) The adult spine, principles and practice, vol 2. Raven Press, p 2002
3. Louis R (1986) Fusion of the lumbar and sacral spine by internal fixation with screw plate. Clin Orthop 203:19–33
4. Matsuzaki H, Tokuhashi Y, Matsumoto E, et al (1990) Problems and solutions of pedicle screw plate fixation of the lumbar spine. Spine 15:1159–1163
5. McGuire RA, Amundson GM (1993) The use of internal fixation in spondylolisthesis. Spine 18:1662–1672
6. Mulholland RC (1994) Pedicle screw fixation in the spine (editorial). J Bone Joint Surg Br 76:517–519
7. Ohlin A, Karlsson M, Duppe H, et al (1994) Complications after transpedicular stabilisation of the spine. Spine 19:2774–2779
8. Roy-Camille R et al (1986) Internal fixation of lumbar spine with pedicle screw plating. Clin Orthop 203:7–17
9. Sanford HD, Myers LM (1992) Complications of lumbar spinal fusion with transpedicular instrumentation. Spine 17:183–189
10. Gertzbein SD, Robbins SE (1990) Accuracy of pedicular screw placement in vivo. Spine 15:11–14
11. Weinstein SL (1994) The paediatric spine, principles and practice, vol 2. Raven Press, p 1723
12. Weinstein JN, Zeilke K, Bohm H (1993) Anatomic and technical consideration of pedicle screw fixation. Clin Orthop 284:34–36
13. West JL, Oglivie JW, Bradford DW (1991) Complications of the variable plate pedicle screw fixation. Spine 16:576–579
14. Zendrick M (1987) Analysis of the morphometric characteristics of the thoracic and lumbar pedicle. Spine 12:160–166