The Accuracy of Pedicle Screw Placement in Thoracic Spine Using the Funnel Technique in Idiopathic Scoliosis

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Study design: *A retrospective study of the accuracy of the pedicle screw placement in the thoracic spine using the Funnel technique in idiopathic scoliosis was conducted by using CT-scan analysis.*
Objective: *To evaluate the accuracy of thoracic pedicle screw placement using the Funnel technique in the surgical management of idiopathic scoliosis.*
Background data: *Placement of thoracic pedicle screw especially in idiopathic scoliosis is technically challenging. CT scan navigator is time-consuming and very expensive. Funnel technique was developed to locate the position of the pedicle and without using the CT guided navigator. There are no reports on the accuracy of pedicle screw instrumentation of the thoracic spine using the funnel technique in scoliosis surgery.*
Material and Method: *117 screws in 14 patients with idiopathic scoliosis were investigated by computed tomography. Screw positioning was analyzed based on each spinal level, side of deformities (convex or concave side) and direction of cortical penetration.*
Result: *Forty-one screws (35%) were placed within the pedicle. Forty-five screws (38%) breeched the medial cortex of pedicle and thirty-one screws (27%) breeched the lateral cortex of pedicle. The percentage of screws totally contained within the pedicle also varied by the thoracic regions: 43% was in between T1-T4, 29% was in between T5-T8, and 37% was in between T9-T12 level. However, there was no statistical difference between the spinal regions and the accuracy rate. Fifty-four screws were placed on the convex side of the spine and sixty-three screws were placed on the concave side. The percentage of totally contained within the pedicle in the convex and the concave side were 20% and 48% respectively. It had statistical difference ($p = 0.004$). Although medial perforation of the pedicle wall occurred in 38%, there were only 6.7% (3/45) of these that had canal encroachment of more than 4 mm. All of these occurred on the convex side. 62% and 31% of screws with medial perforation were less than 2 mm and 2.0-4.0 mm of canal intrusion respectively. Among the lateral penetration, 42% of these screws penetrated < 2 mm., 48% penetrated 2.0-4.0 mm., and 10% penetrated more than 4 mm. There was 3.4% (4/117 screws) that did not purchase the anterior portion of vertebral body. Although the percentage of totally contained screws was low, there was an 82.1% acceptable rate of screw position. These are screws that were fully contained within the pedicle plus medial perforation less than 2 mm. plus screws that had lateral penetration but purchased into the vertebral body). No screws perforated the anterior cortex of the vertebral body. There were no neurovascular complications.*
Conclusion: *Placement of the thoracic pedicle screws using the Funnel technique in idiopathic scoliosis had an accuracy of 82.1%(screws that were in acceptable position). There were no neurovascular related-complications by using this technique in the present study.*

Keywords: *Accuracy, Pedicle screw, Thoracic spine, Scoliosis*

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Scoliosis is a spinal deformity in the coronal sagittal and transverse plane. Segmented spinal fixation with pedicle screws has improved the stability of spinal fusion constructs, produced better correction of spinal alignment with shorter fusion, decreased the incidence of loss or reduction, and early mobilization[1,2].

Although pedicle screws have been generally accepted for lumbar use, many surgeons have doubted that they could be safely used in the thoracic spine especially in scoliosis that may have an abnormality of pedicles[3]. Besides spinal cord or nerve root injury; misplaced screws in the thoracic spine may endanger the intercostal vessels or nerves, esophagus, azygos vein, inferior vena cava, thoracic duct, lungs and sympathetic chain[4]. Several studies have reported pedicle diameters at thoracic spines and shown their variability and accurability for currently available pedicle screw sizes in different population groups[1-3]. There are several methods to reduce the misplacement of the pedicle screw and prevent neurological damage such as using intraoperative sensory - evoked potential monitoring or CT guided navigator[5]. However, it is very expensive, time consuming and rarely available in developing countries. The "Funnel technique", the technique of pedicle screw placement without using the CT guided navigator, has developed and was proven to be safe and simplified[6,7]. The authors applied this technique for placing the thoracic pedicle screw in the surgical correction of idiopathic thoracic scoliosis patients and determined the accuracy by using post operative CT scan. Special attention was focused on the incidence and degrees of cortical breakthrough within the various thoracic regions.

Material and Method

Fourteen idiopathic scoliosis patients (12 females, 2 males) underwent posterior correction and stabilization using 117 titanium transpedicular thoracic screws. One patient who had a rigid thoracic curve also had anterior spinal release. All patients represented the initial use of thoracic pedicle screws by a single surgeon using the "funnel technique"

The Funnel technique[6]

1. The entry point of the pedicle was identified just superior to the intersection between the midline of the base of the transverse process and the lateral border of the facet joint (Fig. 1-A).

2. The posterior cortex of the entry point was removed by a rongeur. About 10 mm of the diameter should be performed (Fig. 1-B).

3. The cancellous bone was removed by a small curette (Fig.1-C).

4. Kerrison rongeur was used to enlarge the cortical pedicle opening if necessary. Further removed of cancellous bone enlarged the pedicle funnel to the upper past of the pedicle isthmus (Fig. 1-D, 1-E).

5. Careful probing of the pedicle isthmus was then performed with a 2-mm pediatric pedicle probe and followed by the standard 4-to-5 mm pedicle probe (Fig. 1-F, 1-G).

6. 50-mm-long, with 2.5 mm in diameter of Steinmann pins were placed into the pedicle. Alignment was checked by fluoroscope both anteroposterior and lateral views (Fig. 1-H, 1-I). The length of the pin was measured to determine the screw length.

7. The pedicle was tapped with taps of gradually increasing diameter to achieve cortical contact and determine the proper screw diameter. The screw diameter was estimated by preoperative plain radiography but the screw diameter was ultimately chosen by the feel and fit of taps used to create threads in the cortex of the isthmus of the pedicle. The feeling of firm cortical purchase was used to determine the outer diameter of the screws (Fig. 1-J).

8. The pedicle wall was checked again with a ball-probe to feel the threads before the appropriate-sized screws were placed into each pedicle (Fig. 1-K, 1-L).

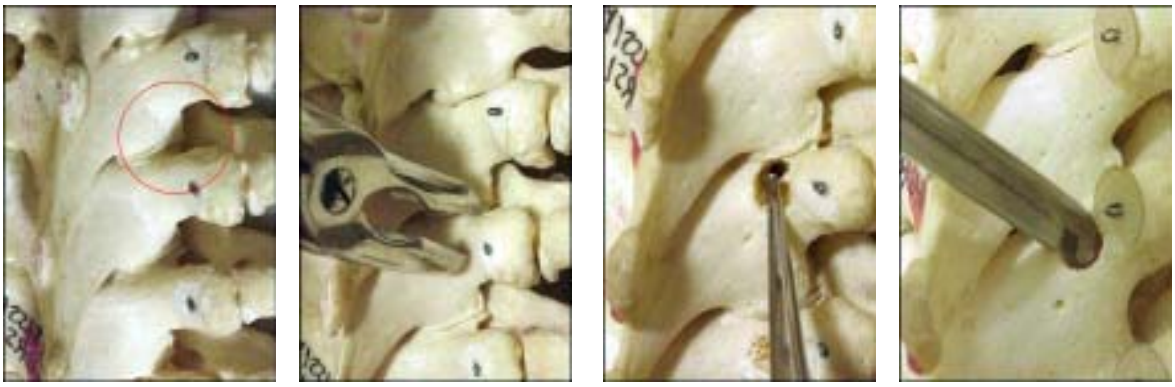
9. The final position and length of each screw were again confirmed by the image intensifier.

All the patients underwent post operative CT scan (Multi slice Somatom Sensation 16 scanner, Seimen) to determine the accuracy of screw placement. A CT scan was done in all patients for assessment to determine the position of the screw by an independent radiologist. Pedicle perforation was classified into medial, lateral and anterior perforation. They were categorized into three groups based on the degree of canal penetration: 1) < 2 mm, 2) 2-4 mm or 3) > 4 mm[8]. Whenever the cortical integrity was questionable, the screws were categorized in the first group. The degree of screw penetration was measured in millimeters.

Base on the anatomy, the authors divided the thoracic spine into 3 regions: 1) T1-T4, 2) T5-T8 and 3) T9-T12. The percentage of screws that were totally contained within the pedicles in each region was compared.

Statistical analysis

All clinical and demographic data such as age at the time of surgery, total blood loss, length of



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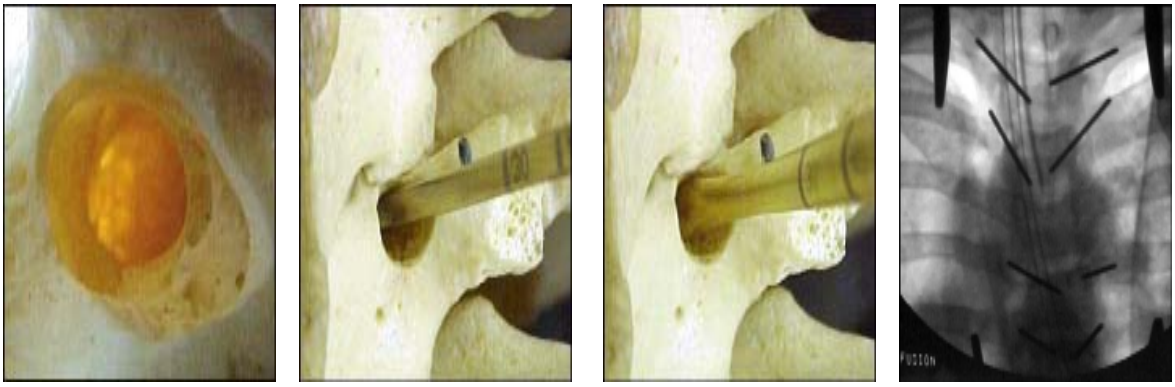

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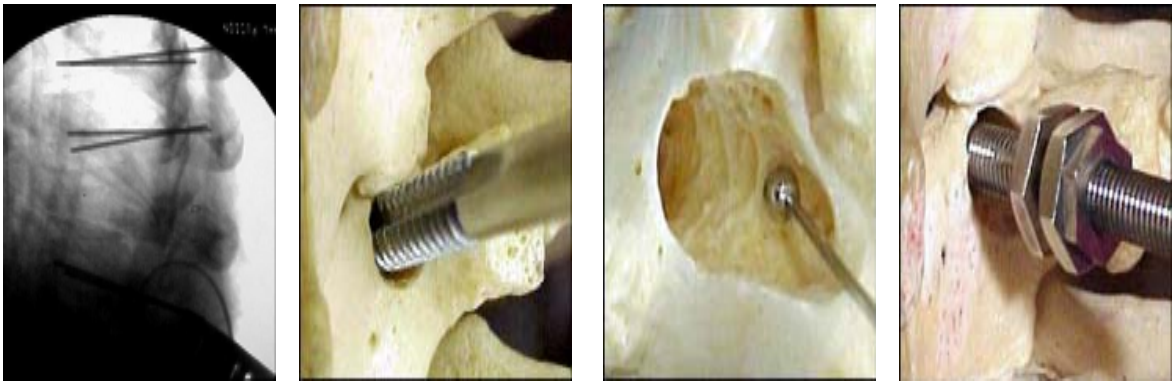

1-I 1-J 1-K 1-L

Fig. 1 A: The posterior projection of the pedicle was estimated (Just superior to the intersection between the midline of the base of the transverse process and the lateral border of the facet joint). B: The posterior cortex overlying the top of the pedicle was removed by a rongeur. C: We remove the cancellous bone from the upper part of the pedicle with a small curette, D: A kerrison rongeur was used to enlarge the cortical pedicle opening if necessary. E: The pedicle can be visualized. F: Careful probing of the pedicle isthmus with A 2-mm pediatric pedicle probe. G: If the pedicle inner diameter allowed, probing it with a standard 4-or 5-mm pedicle probe. H and I : A 55-mm-long K-wire were placed as radiographic markers use an image intensifier to confirm their proper placement. J: The pedicle was then tapped with a 5.5 mm tap. K: All pedicles were then evaluated for perforation using a ball-tip probe. L: Placement pedicle screw was introduced

hospitalization were presented in mean and range. The accuracy of screw placement was shown in the percentage. The association between the accuracy of screw placement and the side of the deformities in the coronal plane, either concave or convex side, was analyzed using the Chi-square test. The accuracy of screw placement in each spinal level was compared using the Chi-square test. Significance was defined on $p \pm 0.05$. Statistical analyses were performed using SPSS version 11.5.

Results

There were 14 patients (2 males and 12 females) with a mean age at the time of detection was 12.77 years (range, 9-19 years) and of surgical treatment was 14.8 years (range, 11.3-21 years). All the patients had a major curve on the right side without positional imbalance. The mean preoperative Cobb angle was 50.57 (range, 35-70 degree). The average postoperative Cobb angle was 15.36 (range, 2-40 digress). Fifty percent of the patient (7/14) had Risser 4 and the remainders were Risser 3 and Risser 0. All the patients were corrected and stabilized posteriorly with thoracic pedicle screws. Only one patient also had anterior release followed by posterior correction and stabilization due to rigid thoracic curve. The mean of operative time was 5.73 hours (range, 1.42-11.75 hours). Total blood loss at intraoperative and postoperative form closed suction drainage was 2,231.43 cc (range, 770-5,460 cc). Length of hospitalization was 11.36 days (range, 5-19 days). The average follow-up was 2.40 years (range, 0.17-4 years). These data are shown in Table 1.

One hundred and seventeen screws were inserted in the thoracic spine. The screw diameter ranged from 4.5 to 5.5 mm. There were 54 screws (46%) placed on the convex side and 63 (54%) on the concave side. The distribution of screw on each spinal level is shown is Table 2.

There were 41 screws (35%) placed within the pedicle without cortical penetration (Fig. 2).

The other 76 screws (65%) had cortical penetration. There were 45 screws (38%) with medial pedicle penetration and 31 (27%) with lateral pedicle penetration (Fig. 3).

Among the 54 screws that were placed on the convex side, 11 screws (20%) were fully contained within the pedicle. Unlike the convex side, there were 48% of screws fully contained within the pedicle on the concave side. This was statistically significant ($p = 0.004$) (Table 3).

Table 1. Demographic data

Patient (n)	14
Male	2
Female	12
Age at the time of patient detection	12.7 years (9-19 years)
Age at the time of surgery	14.8 years (11.3-21 years)
Menarchal Status	
Premenarche	17% (2/12)
Postmenarchae	83% (10/12)
Risser Sign	
Risser 0	21% (3/14)
Risser 3	29% (4/14)
Risser 4	50% (7/14)
Preoperative Cobb angle	50.8 (35 -70)
Postoperative Cobb angle	15.4 (2 -40)
Duration of Surgery	5.73 hours (1.42-11.75 hours)
Total blood loss	2,331.43 cc (770-5,460 cc)
Length of hospitalization	11.4 days (5-19 days)
Duration of the follow up	2.40 years (0.17-4.0 years)

Table 2. Distribution of pedicle screws in the spine

Level	Total of pedicle screws	Convex	Concave
T1	2	1	1
T2	4	1	3
T3	3	1	2
T4	12	6	6
T5	9	4	5
T6	11	6	5
T7	10	5	5
T8	12	6	6
T9	14	7	7
T10	17	7	10
T11	11	9	6
T12	12	5	7
Total	117 (100%)	54 (46%)	63 (54%)

Based on the distribution of the screws, 21 screws were placed at T1-T4 level, 42 at the T5-T8 level and 54 at the T9-T12 level. The percentage of screws totally contained within the pedicle also varied by thoracic region: 43% at T1-T4, 29% at T5-T8 and 37% at T9-T12 level but were not statistically different (T1-

Table 3. The result of screw placement on the convex and concave side of the spine

	Fully contained	Cortical penetrate	Total	p-value
Convex	11	43	54	0.004*
Concave	30	33	63	0.004*

* Chi-square test

T4 vs T5-T8; p = 0.395), (T1-T4 vs T9-T12; p = 0.841), (T5-T8 vs T9-T12; p = 0.513) (Fig. 4).

Among the subset of screws that had medial penetration, there were three (7%) that had medially penetrated more than 4 mm (Fig. 5). One had 4.5 mm of perforation on T8 level and two had 5.0 mm of perforation on T11 and T12 spinal levels. All of these screws were placed on the convex side. There were 28 screws (62%) that had medial penetration less than 2 mm and 14 screws (31%) with medial penetration of 2-4 mm.

Of 31 screws that had lateral pedicle penetration, 13 screws (42%) had less than 2 mm, 15 screws (48%) had 2-4 mm and three screws(10%) had more than 4 mm. Four screws did not penetrate into the vertebral body (Fig. 6).

The result of screw placement based on the severity of penetration is shown in Table 4.

None of the screws made anterior penetration of the vertebral body. No neurovascular complications occurred post operatively.

Discussion

Currently, there have been many reports about the accuracy rate of screw placement in the thoracic spine, but very few of them were in the spinal deformity such as scoliosis. Belmont[9] reported 42%

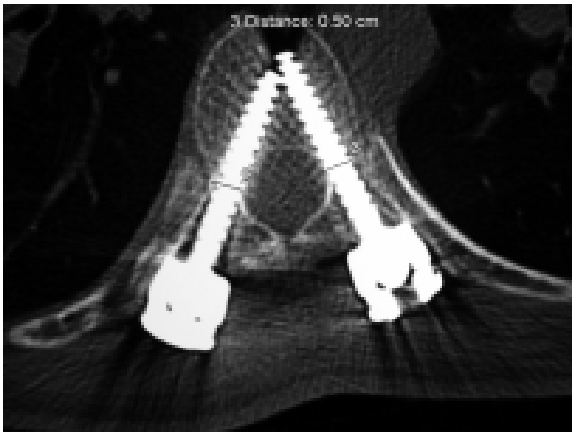

Fig. 2 Screws were placed within the pedicle without cortical penetration

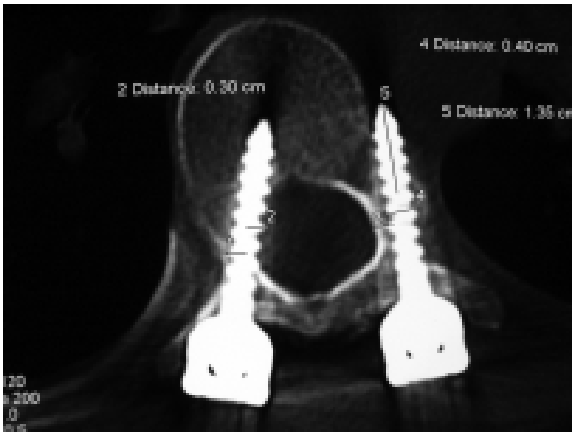

Fig. 3 Screws were placed with medial pedicle penetration (Lt.) and lateral pedicle penetration (Rt.)

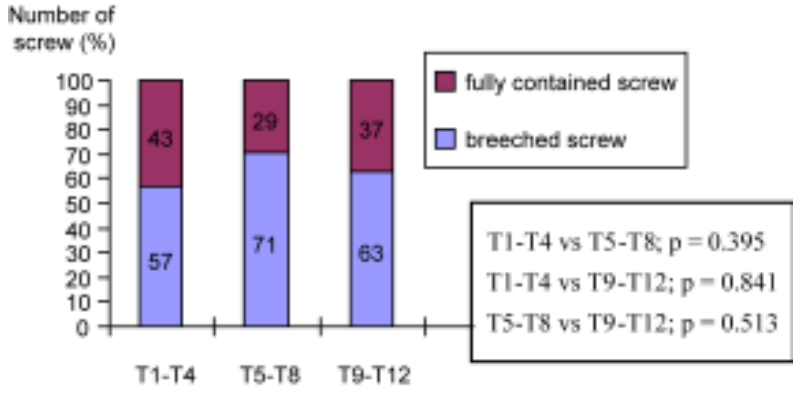

Fig. 4 The accuracy of screw placement in three groups of the patients

Table 4. The results of screw placement based on the severity of penetration

Level	Number of screws	Continued	Cortical perforation (mm)					
			Medial			Lateral		
			< 2 mm	2-4 mm	> 4 ~ mm	< 2 mm	2-4 mm	> 4 ~ mm
T1	2	-	-	-	-	-	-	2
T2	4	2	-	-	-	2	-	-
T3	3	1	-	-	-	-	2	-
T4	12	6	1	2	-	1	2	-
T5	9	4	2	1	-	-	2	-
T6	11	1	4	2	-	2	2	-
T7	10	3	4	1	-	1	1	-
T8	12	4	3	3	1	-	1	-
T9	14	4	4	1	-	2	3	-
T10	17	7	6	3	-	-	1	-
T11	11	4	1	-	1	3	1	1
T12	12	5	3	1	1	2	-	-
Total	117 (100%)	41 (35%)	28	14	3	13	15	3
			45 (38%)			31 (27%)		

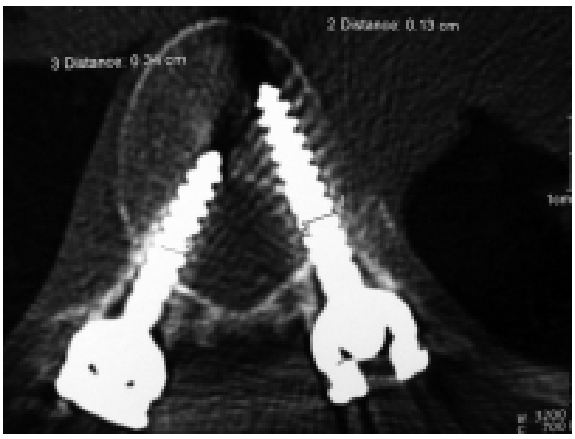

Fig. 5 Screws had more than 4 mm. of medial penetration (Lt.)

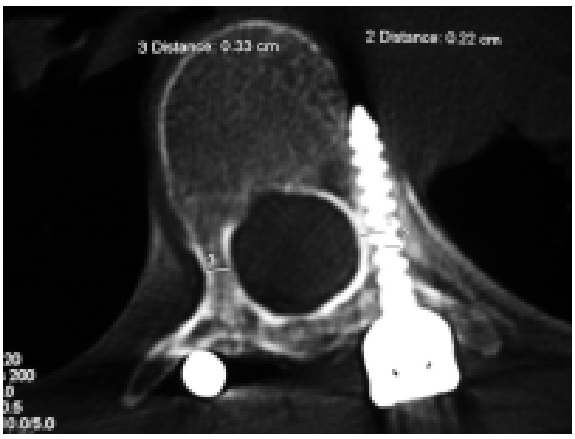

Fig. 6 Screw had lateral penetration and did not purchase the anterior vertebral body

of fully contained screws in the patients who had coronal plane spinal deformities (adolescent idiopathic scoliosis, adult scoliosis, congenital scoliosis, neuromuscular scoliosis). The accuracy was significantly lower than in the patients without spinal deformities. Suk[10] found 24% of screw mal-position in the patients with idiopathic scoliosis. The number of screw mal-position analysis in his studies maybe inaccurate because evaluation of screws position using only plain radiographs had a very high rate of false-positive and false-negative[11]. Furthermore, he did not perform post operative CT scan routinely in every case but only in the patients who were suspicious of screw malposition seen on the post operative plain radiographs.

Liljenquist[12] used CT scan to determine post operative screw positioning in the thoracic spine in idiopathic scoliosis patients. One hundred and twenty screws were placed in the thoracic spine T4-T12 in 32 patients. He reported a 25% incidence of the screws penetration of pedicle cortex or the anterior cortex of

vertebral body. In the present study, the correlation between the pedicle cortical penetration rate and the preoperative Cobb angle, vertebral rotation, level of the spine, and site of screw insertion were statistically insignificant.

Medial perforation is certainly the most focused screw misplacement because spinal canal encroachment may lead to spinal cord injury. Reynolds et al[13], using epidural contrast, demonstrated radiographic evidence of more than 2 mm of lateral epidural space from T7-L4. Gertzbein and Robbins[8] assessed the accuracy of pedicle screw placement in 40 patients with mostly thoracolumbar fractures by means of post operative computed tomography. Seventy-one screws were inserted in the thoracic spine (T8-T12). There were 70% of thoracic pedicle screws placed correctly in the pedicle. About 10.0% of the screws had penetrated the medial pedicle cortex by less than 2 mm, 8.5% had penetrated by between 2.1 and 4 mm. In addition, 7.0% of the screws were encroached the spinal canal by between 4.1 and 8 mm. Two patients with spinal canal encroaching between 6-7 mm, developed neurological symptoms. They extrapolated that a 4 mm was the "safe zone" of medial encroachment into the spinal canal of the pedicle screws, which included the 2 mm of epidural space and the 2 mm of subarachnoid space.

In the present study, there were 45 screws (38%) penetrating the medial pedicle cortex. but no patients developed neurological complication related to screw misplacement. Moreover, among these, three screws had medial perforation more than 4 mm. All of these occurred on the convex side and no patients developed neurological complications. The present findings supported the study by Rauschning[14], who dissected the human cadavers with scoliosis and showing a shift of the dural sac to the concave side of the scoliosis curve with direct proximity to the pedicle. This implies that medial pedicle penetration of the screw on the convex side might be tolerated better with lesser risk of injury to the spinal cord than penetration on the concave side.

Based on these standards, the authors accepted less than 2 mm. of medial perforation instead of 4 mm. for medially positioned screws as acceptable. Therefore, 28 of the 45 screws that perforated the medial cortex of the pedicle were acceptable.

Concerning the lateral cortical penetration, Husted[15] and Dvorak[16] reported extra pedicle screw placement that was in the safe and accepted biomechanics in placement of pedicle screws in the thoracic spine. For this reason, the authors accepted the position of the screws that penetrated pedicle wall laterally like the "in-out-in" technique reported by Belmont[9]. Therefore, 27 screws that penetrated the lateral pedicle, except for four screws that did not purchase into the vertebral body, were acceptable.

As in the above studies, although the accuracy rate of totally contained screw placement using funnel technique was 35%, this technique revealed an 82% (96/117) acceptable rate for placing the pedicle screws in the deformed thoracic spine. At present, computerized tomography scan navigator may be used to assist the pedicle screw placement. Heary[17] reported 86.5% of screws fully contained within the pedicle with CT-navigator. However, there have been no studies using the CT-navigator assisted in patients who have idiopathic scoliosis. There have been no studies about the cost-effectiveness in placement of the screws in the thoracic spine comparing usage of the CT scan guiding navigator and conventional method (without navigator). Further study is needed.

Finally, the technique of screw placement is the only one of many factors that determines the accuracy. Surgical experience, degree of spinal deformity and degree of vertebral rotation may be other important factors. However, the present study had some limitations. The authors did not perform the pre-operative CT scan, so the authors could not predict the direction and the dimension of the screws accurately. Although there were many studies representing the size of the pedicle in the thoracic spine[4,18], none of those studies were done in an Asian population who have smaller bodies than western people. Currently, there is no unique standard technique for thoracic pedicle screw placement especially in scoliosis, so the authors did not have a control group to compare the accuracy of screw placement techniques. Furthermore, it is more difficult to compare the results with the other studies because of the different population.

Conclusion

1. In idiopathic scoliosis, the "Funnel technique" for placement of thoracic pedicle screws had an accuracy rate of 82.1%(screws placed in an acceptable position). Among these, 35% were found to be fully-contained in the pedicle.
2. The accuracy of screw placement in the thoracic spine between the spinal regions (T-1-T4, T5-T8, and T9-T12) had no significant statistical difference.
3. The screws that were placed on the convex side

had a significantly higher risk of penetration of the pedicle than on the concave side ($p = 0.004$).

5. No patients in the present study had neurovascular complications by using the Funnel technique.
6. Using the Funnel technique for placement of pedicle screws in the thoracic spine in idiopathic scoliosis is simple, safe with high accuracy rate and is comparable to the CT- navigator assisted technique.

References

1. Aebi M, Etter C, Kehl T, Thalgott J. Stabilization of the lower thoracic and lumbar spine with the internal spinal skeletal fixation system. Indications, techniques, and first results of treatment. Spine 1987; 12: 544-51.
2. Parker JW, Lane JR, Karaikovic EE, Gaines RW. Successful short-segment instrumentation and fusion for thoracolumbar spine fractures: a consecutive 41/2-year series. Spine 2000; 25: 1157-70.
3. O'Brien MF, Lenke LG, Mardjetko S, Lowe TG, Kong Y, Eck K, et al. Pedicle morphology in thoracic adolescent idiopathic scoliosis: is pedicle fixation an anatomically viable technique? Spine 2000; 25: 2285-93.
4. Vaccaro AR, Rizzolo SJ, Balderston RA, Allardyce TJ, Garfin SR, Dolinskas C, et al. Placement of pedicle screws in the thoracic spine. Part II: An anatomical and radiographic assessment. J Bone Joint Surg Am 1995; 77: 1200-6.
5. Glossop ND, Hu RW, Randle JA. Computer-aided pedicle screw placement using frameless stereotaxis. Spine 1996; 21: 2026-34.
6. Yingsakmonkol W, Karaikovic E, Gaines RW. The accuracy of pedicle screw placement in the thoracic spine using the "Funnel Technique": part 1. A cadaveric study. J Spinal Disord Tech 2002; 15: 445-9.
7. Viau M, Tarbox BB, Wonglertsiri S, Karaikovic EE, Yingsakmongkol W, Gaines RW. Thoracic pedicle screw instrumentation using the "Funnel Technique": part 2. Clinical experience. J Spinal Disord Tech 2002; 15: 450-3.
8. Gertzbein SD, Robbins SE. Accuracy of pedicular screw placement in vivo. Spine 1990; 15: 11-4.
9. Belmont PJ Jr, Klemme WR, Robinson M, Polly DW Jr. Accuracy of thoracic pedicle screws in patients with and without coronal plane spinal deformities. Spine 2002; 27: 1558-66.
10. Suk SI, Kim WJ, Lee SM, Kim JH, Chung ER. Thoracic pedicle screw fixation in spinal deformities: are they really safe? Spine 2001; 26: 2049-57.
11. Weinstein JN, Spratt KF, Spengler D, Brick C, Reid S. Spinal pedicle fixation: reliability and validity of roentgenogram-based assessment and surgical factors on successful screw placement. Spine 1988; 13: 1012-8.
12. Liljenqvist UR, Halm HF, Link TM. Pedicle screw instrumentation of the thoracic spine in idiopathic scoliosis. Spine 1997; 22: 2239-45.
13. Reynolds AF Jr, Roberts PA, Pollay M, Stratemeier PH. Quantitative anatomy of the thoracolumbar epidural space. Neurosurgery 1985; 17: 905-7.
14. Rauschning W. Anterior surgery of the thoracolumbar junction and the lumbar spine. Anatomy, complications, safe guards. Presented at the meeting Anterior Spine Surgery: Standards and New Techniques. Berlin, Germany, October 25-27, 1995.
15. Husted DS, Yue JJ, Fairchild TA, Haims AH. An extrapedicular approach to the placement of screws in the thoracic spine: an anatomic and radiographic assessment. Spine 2003; 28: 2324-30.
16. Dvorak M, MacDonald S, Gurr KR, Bailey SI, Haddad RG. An anatomic, radiographic, and biomechanical assessment of extrapedicular screw fixation in the thoracic spine. Spine 1993; 18: 1689-94.
17. Zindrick MR, Wiltse LL, Doornik A, Widell EH, Knight GW, Patwardhan AG, et al. Analysis of the morphometric characteristics of the thoracic and lumbar pedicles. Spine 1987; 12: 160-6.
18. Heary RF, Bono CM, Black M. Thoracic pedicle screws: postoperative computerized tomography scanning assessment. J Neurosurg 2004; 100: 325-31.

การศึกษาความแม่นยำของการผ่าตัดใส่ตะปูเกลียวบริเวณกระดูกหลังช่วงอกในผู้ป่วยโรคกระดูกสันหลังคดชนิดไม่ทราบสาเหตุ โดยวิธี Funnel Technique

วิชาญ ยิ่งศักดิ์มงคล, นราพงษ์ หังสพฤกษ, สุกัลยา เลิศล้ำ

รูปแบบการวิจัย: *การศึกษาย้อนหลังเพื่อประเมินความแม่นยำของการใส่ตะปูเกลียวบริเวณกระดูกสันหลังช่วงอกในผู้ป่วยที่เป็นกระดูกสันหลังคดโดยไม่ทราบสาเหตุและได้รับการผ่าตัด โดยการใช้วิธีเจาะรูเป็นรูปกรวย*

วัตถุประสงค์: *เพื่อศึกษาความแม่นยำของการผ่าตัดใส่ตะปูเกลียวที่กระดูกสันหลังช่วงอกในผู้ป่วยกระดูกสันหลังคดโดยไม่ทราบสาเหตุ ด้วยวิธีเจาะรูเป็นกรวย*

ข้อมูลพื้นฐาน: *การใส่ตะปูเกลียวบริเวณกระดูกสันหลังช่วงอกจำเป็นต้องใช้ความชำนาญ โดยเฉพาะอย่างยิ่งในผู้ป่วยที่กระดูกสันหลังคดโดยไม่ทราบสาเหตุ ซึ่งจะมีการผิดรูปของกระดูกสันหลังด้วย ในขณะนี้ได้มีการนำเอกซเรย์คอมพิวเตอร์นำวิถีมาประกอบเพื่อเพิ่มความแม่นยำในการผ่าตัดใส่ตะปูเกลียวในกระดูกสันหลังส่วนอก แต่วิธีการดังกล่าวเป็นวิธีที่ทำให้การใช้เวลาในการผ่าตัดนานมากขึ้นและเพิ่มค่าใช้จ่ายค่อนข้างสูง นอกจากนี้ยังไม่สามารถจัดหาได้ในทุกโรงพยาบาล จึงได้มีการพัฒนาวิธีการใส่ตะปูเกลียวโดยทำการตัดกระดูกบริเวณทางเข้าของตะปูเกลียวเป็นรูปกรวยซึ่งสามารถเห็นแนวของเพดิเคิลได้โดยตรง ซึ่งให้ความแม่นยำในการใส่ตะปูเกลียวที่บริเวณดังกล่าวโดยยังไม่เคยมีรายงานถึงความแม่นยำในการผ่าตัดกับผู้ป่วยกระดูกสันหลังคดโดยใช้เอกซเรย์คอมพิวเตอร์เลย*

วัสดุและวิธีการ: *ทำการศึกษาในผู้ป่วยที่ได้รับการผ่าตัดใส่ตะปูเกลียวโดยทำการตัดกระดูกบริเวณทางเข้าของตะปูเกลียวเป็นรูปกรวย รวมจำนวนของตะปูเกลียวที่ใส่ในบริเวณกระดูกหลังส่วนอกทั้งสิ้นจำนวน 117 ตัว ในผู้ป่วย 14 ราย ที่ได้รับการวินิจฉัยว่าเป็นกระดูกสันหลังช่วงอกคดโดยไม่ทราบสาเหตุ และนำมาคำนวณหาความแม่นยำของการใส่ตะปูเกลียวเข้าไปในเพดิเคิล ซึ่งประเมินความแม่นยำของการใส่ตะปูเกลียวโดยการเอกซเรย์คอมพิวเตอร์และการหาความสัมพันธ์ของความแม่นยำของการใส่ตะปูเกลียวกับระดับของกระดูกสันหลัง รวมทั้งวิเคราะห์ทิศทางการทะลุของตะปูเกลียว อีกทั้งหาความสัมพันธ์ของความแม่นยำของการใส่ตะปูเกลียวกับความผิดปรกติในด้านนูนและด้านเว้า*

ผลการศึกษา: *จากการศึกษาตะปูเกลียวจำนวน 117 ตัว ผลปรากฏว่ามีตะปูเกลียวจำนวน 41 ตัวอยู่ในเพดิเคิลอย่างสมบูรณ์ โดยไม่มีการทะลุเลยคิดเป็นร้อยละ 35 ของตะปูเกลียวทั้งหมด มีตะปูเกลียวที่ทะลุทางด้านในของเพดิเคิลจำนวน 45 ตัว คิดเป็นร้อยละ 38 ของตะปูเกลียวทั้งหมด และทะลุทางด้านนอกของเพดิเคิลจำนวน 31 ตัว คิดเป็นร้อยละ 27 ของจำนวนตะปูเกลียวทั้งหมด*

จากผลการศึกษา พบว่าความแม่นยำของการใส่ตะปูเกลียวเปรียบเทียบกับระดับของกระดูกสันหลังไม่มีความแตกต่างกันทางสถิติ (T1-T4 กับ T5-T8; p = 0.395, T1-T4 กับ T9-T12; p = 0.841 และ T5-T8 กับ T9-T12, p = 0.513) มีตะปูเกลียวจำนวน 54 ตัวอยู่ทางด้านนูนของกระดูกสันหลัง (convex side) และมีจำนวน 63 ตัวอยู่ทางด้านเว้า (concave side) โดยพบว่าความแม่นยำของการใส่ตะปูเกลียวทางด้านเว้าสูงกว่าทางด้านนูนอย่างมีนัยสำคัญทางสถิติ (48% เทียบกับ 20%; p = 0.004)

จากตะปูเกลียวที่ทะลุทางด้านในของเพดิเคิลจำนวน 45 ตัวมีตะปูเกลียวจำนวน 28 ตัว ทะลุน้อยกว่า 2 มิลลิเมตร คิดเป็นร้อยละ 62 ของตะปูเกลียวที่ทะลุทางด้านใน มีตะปูเกลียวจำนวน 14 ตัวที่ทะลุ 2-4 มิลลิเมตร และมีตะปูเกลียว 3 ตัวทะลุมากกว่า 4 มิลลิเมตร คิดเป็นร้อยละ31 และ 6.7 ของตะปูเกลียวที่ทะลุทางด้านในของเพดิเคิลตามลำดับ

สำหรับตะปูเกลียวที่ทะลุทางด้านนอกของเพดิเคิลจำนวน 31 ตัว มีตะปูเกลียว 13 ตัวทะลุน้อยกว่า 2 มิลลิเมตร คิดเป็นร้อยละ 42 ของตะปูเกลียวที่ทะลุทางด้านนอกของเพดิเคิล และมีตะปูเกลียวจำนวน 15 ตัวและ 3 ตัว ทะลุเพดิเคิลทางด้านนอก 2-4 มิลลิเมตร และ มากกว่า 4 มิลลิเมตร ตามลำดับ คิดเป็นร้อยละ 48 และ 10 ของตะปูเกลียวที่ทะลุทางด้านนอกของเพดิเคิล มีตะปูเกลียวจำนวน 4 ตัวที่ไม่เข้ากระดูกสันหลัง

จากการศึกษานี้ แม้ว่าจำนวนของตะปูเกลียวที่ไม่ทะลุเพดิเคิลจะต่ำ (35%) แต่หากพิจารณาถึงตำแหน่งของตะปูเกลียวที่สามารถยอมรับได้ (ตะปูเกลียวที่ไม่ทะลุเพดิเคิล + ตะปูเกลียวที่ทะลุเพดิเคิลทางด้านในน้อยกว่า 2 มิลลิเมตร + ตะปูเกลียวที่ทะลุเพดิเคิลทางด้านนอกแต่แทงเข้าไปในกระดูกสันหลัง) พบว่ามีจำนวนตะปูเกลียวถึง 96 ตัว อยู่ในตำแหน่งที่สามารถยอมรับได้ คิดเป็นร้อยละ 82.1 ของจำนวนตะปูเกลียวทั้งหมด

ไม่พบว่ามีตะปูเกลียวแทงทะลุทางด้านหน้าของกระดูกสันหลัง และไม่พบภาวะแทรกซ้อนทางระบบประสาทและหลอดเลือดในผู้ป่วยที่เข้ารับการศึกษาในครั้งนี้

***สรุป**: การใส่ตะปูเกลียวโดยวิธีเจาะรูเป็นรูปกรวย ในผู้ป่วยกระดูกสันหลังคดบริเวณช่วงอกโดยไม่ทราบสาเหตุ ให้ความแม่นยำของการใส่ตะปูเกลียวถึงร้อยละ 82 ที่อยู่ในตำแหน่งที่สามารถยอมรับได้ และไม่มีผู้ป่วยรายใดเกิดภาวะแทรกซ้อนทางระบบประสาทและหลอดเลือดจากการใช้เทคนิคดังกล่าว*