Comparative study between percutaneous and open transpedicular fixation in thoracolumbar fractures

Mohamed Salem Mohamed [2] , Shehab Mohamed Elkhadrawy[1],Mohammed Mohammed Elsayed Ali Saleh [2*], Mohammed Sayed Ismail El-Shandawelly[2]

1. Neurosurgical Department, Faculty of Medicine, Al Azhar University, Cairo, Egypt
2. Neurosurgical Department, Faculty of Medicine, Al Azhar University, Assuit, Egypt

* Corresponding author, Email: mohammedneuro79@gmail.com

Abstract

The use of posterior pedicle screw fixation has increasingly become more prevalent in the treatment of thoracolumbar fractures. The use of pedicle screw plates in the treatment of thoracolumbar fractures was first presented by Roy-Camille et al in 1963. The objective of this study was to evaluate the efficacy, effectiveness, and safety of percutaneous pedicle screw fixation as a treatment option for thoracolumbar fractures, in contrast to the usual open posterior short-segment pedicle screw operation. So, this study was carried out 40 patients presented categorized into; 20 of total patients treated by conventional open posterior and the other was treated by percutaneous fixation at Al-Azhar University hospitals from June 2019 to September 2020. All participants exhibited no neurological deficits and were immobilized at a level one segment above and below the fractured vertebra. The clinical and functional results indicate a preference for or equivalence between percutaneous fixation and traditional surgical interventions. Radiation exposure is the biggest risk, but the new 3D CT screw placement method can cut that risk down a bit. Percutaneous transpedicular spine fixation is a reliable method that works the same way as open treatments. It lets the surgeon fix the spine securely inside while causing as little damage to the surrounding tissues as possible. This approach represents a viable choice for managing unstable thoracolumbar fractures in the absence of neurological impairment. One notable benefit is its ability to minimize surgical duration, eliminate blood loss, and significantly reduce muscular trauma, hence resulting in less postoperative pain compared to conventional open procedures. Additionally, patients using this technique have shorter hospital stays, earlier mobility, quicker reintegration into the workforce, and a lower likelihood of encountering problems.

KeyWords:percutaneous transpedicular thoracolumbar fixation, segment fixation, thoracolumbar fracture

DOINumber:10.48047/nq.2021.19.1.NQ21022 **NeuroQuantology2021;19(1):165-169**

BACKGROUND:

Fractures of the thoracolumbar spine are often seen, constituting about 60% of all acute spinal fractures[1]. A significant proportion of thoracolumbar fractures are seen within the T11 to L2 levels, rendering this region susceptible to external stresses [2]. Treatment choices including surgical and conservative treatment, relies on the fracture's specific conditions. Management of Surgical in thoracolumbar fractures usually obtain better clinical findings besides conventional treatment, such as immobilization and in bed rest [3]. The significance of spine fractures has grown in prominence over the last two decades due to the advent of contemporary and more sophisticated surgical interventions. There exist several scholarly articles that delineate diverse surgical methodologies used in the stabilization and reduction of thoracolumbar fractures, in addition to consultations. There exists a lack of unanimity among writers about the appropriate approach to therapy [4]. Traditional open spine surgery is associated with many disadvantages, such as substantial blood loss, susceptibility to infection, and the occurrence of postoperative muscular discomfort. The process of dissecting paravertebral muscles for the purpose of internal spine stabilization has the possibility of causing denervation, increased intramuscular tension, ischemia, necrosis, and eventual revascularization. All of these mechanisms possess the capacity to induce muscle atrophy and scarring subsequent to surgical interventions, sometimes accompanied by prolonged

postoperative discomfort and functional impairment[5].

In contemporary times, the use of percutaneous fixation has shown efficacy as a strategy for the treatment of thoracolumbar fractures. The primary purpose of this technique is to minimize damage to soft tissues and reduce perioperative problems [6]. The technique of percutaneous fixation was first introduced by Magerl, who used an external fixator. Subsequently, Mathews and Long further elucidated and advanced the percutaneous lumbar pedicle fixation methods, using plates as longitudinal connectors. Consequently, Lowery and Kulkarni discovered a comparable methodology including the insertion of rods, whereas Mathews and Long noticed a substantial incidence of non-union [7]. Two previous methods, the longitudinal connectors were located either superficially or externally under the skin. The subject under consideration presents several perceived drawbacks. Firstly, the presence of surface connections is found to be difficult and necessitates their elimination. Secondly, the utilization of longer screws, which consequently leads to longer moment arms, is necessary in order to attain a biomechanical stability that is less effective compared to that offered by the conventional pedicle fixing device. This, in turn, results in an augmented likelihood of implant failure [7]. To solve the challenges associated with conventional posterior spinal fixation and the issues related to superficially mounted hardware, certain percutaneous spinal fixation systems have been devised. These systems involve placing the hardware in direct contact with the bone, thereby allowing for fixation that closely resembles the process of inserting screws in an open procedure. The systems under consideration are the SEXTANT, path finder, and World Spine Highlight (W.S.H.) systems. These systems use rods and plates as longitudinal connectors, with the SEXTANT system using rods and the path finder and W.S.H. systems employing plates[8].

AIM OF THE WORK

Percutaneous pedicle screw fixation is an alternative to the standard open posterior short-segment pedicle screw surgery for treating thoracolumbar fractures; this study aims to evaluate its efficiency, safety, and effectiveness.

METHODS AND PATIENTS

This research presents a prospective and retrospective analysis done on a cohort of 40 individuals diagnosed with thoracolumbar fractures. During the period from June 2019 to September 2020, a total of 40 patients were treated for their condition. Among them, 20 patients had percutaneous pedicle screw fixation, while the other 20 patients underwent standard open fixation at Al-Azhar University Hospital. All individuals exhibited freedom from neurological conditions.

During the 6-month follow-up period, patients were seen twice post-operatively to remove sutures, then once a month for three consecutive months. After three months, they had clinical and radiological evaluations.

Statistical analysis:

The primary concern is to the potential exposure to radiation; however, the use of the novel 3D CT screw insertion technique has the potential to mitigate this danger. The percutaneous transpedicular spine fixation technique demonstrates favorable outcomes and adheres to same principles as conventional surgical procedures. The surgical procedure enables the physician to safely stabilize the spinal column while minimizing the extent of harm inflicted upon the adjacent tissues.

RESULTS

Table (1): Regarding as demographic data, comparison among open fixation and percutaneous fixation.

Demographic data	Percutaneous fixation (n=20)	Open fixation (n=20)	Test	p-value
SEX				
Female	9 (45.0%)	8 (40.0%)		
Male	11 (55.0%)	12 (60.0%)	x^2=0.102	0.749
Age (years)				
Mean±SD	31.00±9.97	30.40±10.37		
Range	17-51	18-55	t=0.187	0.853

Table 1 illustrates that there is no significant difference between open fixation and percutaneous fixation in terms of demographic data.

Table (2): Regarding as injury, Comparison among open fixation and percutaneous fixation.

Injury	Percutaneous fixation (n=20)	Open fixation (n=20)	Test	p-value
Level of injury				
D12	0 (0.0%)	2 (10.0%)		
L1	7 (35.0%)	5 (25.0%)		
L2	6 (30.0%)	5 (25.0%)	x^2=3.202	0.525
L3	5 (25.0%)	4 (20.0%)		
L4	2 (10.0%)	4 (20.0%)		
Mechanism of injury				
F.F.H	11 (55.0%)	13 (65.0%)	x^2=0.417	0.519
R.T.A	9 (45.0%)	7 (35.0%)		

Using: x^2: Chi-square test

Table 1 illustrates that there is no significant difference between percutaneous fixation and open fixation.

Table (3): According to duration of surgery (min), Comparison between open fixation and percutaneous fixation.

Duration of surgery (min)	Percutaneous fixation (n=20)	Open fixation (n=20)	Test	p-value
Mean±SD	79.00±13.24	81.75±12.17	t=-0.684	0.498
Range	60-110	60-110		

Based on the recorded length of operation in minutes, Table 3 illustrates that there is no significant difference seen between open and percutaneous fixation methods.

Table (4): Comparison among open fixation and percutaneous fixation according to blood loss (cc).

Blood Loss (cc)	Percutaneous fixation (n=20)	Open fixation (n=20)	Test	p-value
Mean±SD	85.00±16.70	550.00±146.90	t=-14.066	<0.001**
Range	60-120	400-900		

Using: t-Independent Sample t-test

Table (4) demonstrates highly significant elevate mean blood loss in open fixation compared to percutaneous fixation.

Table (5): Comparison among open fixation and percutaneous fixation according to radiation exposure, hospital stay and screw position.

	Percutaneous fixation (n=20)	Open fixation (n=20)	Test	p-value
Radiation exposure (min)				
Mean±SD	3.25±0.64	1.68±0.44	t=9.098	<0.001**
Range	2.5-5	1-2.5		
Hospital stay (days)				
Mean±SD	2.50±0.69	4.10±0.85	t=-6.532	<0.001**
Range	2-4	3-6		

Using: t-Independent Sample t-test; x2: Chi-square test.

Table 5 illustrates a substantial disparity in hospital stay and radiation exposure between open fixation and percutaneous fixation methods.

Table (6): Comparison among percutaneous fixation and open fixation regarding as back pain.

Back pain	Percutaneous fixation (n=20)	Open fixation (n=20)	Test	p-value
Pre-operative				
Mean±SD	4.25±0.44	4.30±0.47	t=-0.346	0.731
Range	4-5	4-5		
Post-operative at 6 months				
Mean±SD	1.10±0.31	2.35±0.49	t=-9.670	<0.001**
Range	1-2	2-3		
Difference				
Mean±SD	-3.15±0.49	-1.95±0.51	t=-7.589	<0.001**
Range	-4 – -2	-3 – -1		

Using: t-Independent Sample t-test; p-value>0.05 NS; *p-value <0.05.

Table 6 presents a notable reduction in mean back pain at the six-month post-operative period for percutaneous fixation as compared to open fixation. The data indicates a very significant decrease in mean difference for percutaneous fixation as compared to

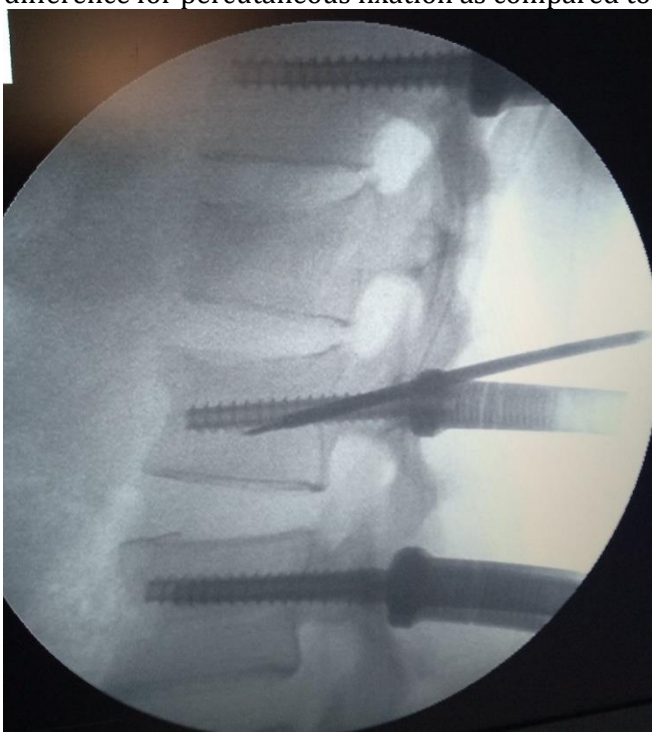

Figure (1): during percutaneous fixation lateral view (Percutaneous fixation)

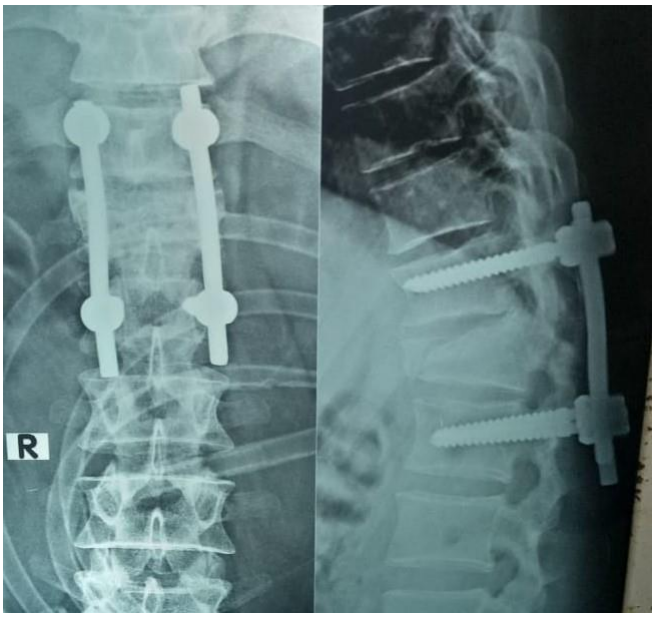

Figure (2): Open fixation

DISCUSSION

The conventional open method for thoracolumbar spine fixation requires a substantial soft tissue incision, which is performed to facilitate the attachment of the pedicle to the screw and expose the bony structure of the spine. The dissection process leads to many repercussions, including denervation of the paraspinal muscles, leading in ischemia of the soft tissues and muscles. furthermore, intense postoperative pain, longer recovery times, and, in rare cases, failure of fracture stabilization may occur as well [9].

The present study employs both retrospective and prospective techniques, including a cohort of 40 patients. Data collecting started in March 2019 and concluded in April 2020. A cohort of 40 patients was partitioned into 2 groups, whereby 20 participants were subjected to normal open fixation therapy and the other 20 underwent percutaneous fixation. The present study examined the average time of open fixation surgery, which was found to be 81.75±12.17. In contrast, the average duration of percutaneous fixation surgery was discovered to be 79.00±13.24. Wild et al [10] In contrast to the conventional pedicle screw fixation approach, which might take anywhere from eighty-one to two hundred and forty minutes, the average time required for percutaneous fixation (47.0 min ± 14.4) was much shorter, as stated in the literature on the subject. Merom et al. [11] Ahmed reported that the length of the percutaneous short-segment fixation surgical operation varied between 73 and 85 minutes, which exhibited a relatively shorter timeframe compared to the operating time for conventional fixation, which ranged from 78 to 102 minutes. In the investigation conducted by the researchers, Ni et al. (12) The average length for percutaneous short-segment fixation operations was found to be 70 minutes, as described in the literature. When doing a comparative analysis of open operations In the course of their investigation, Ni et al. (2012) documented an average operational duration of around 153 minutes (range: 125 – 205 minutes) for open pedicle screw fixation. In our study, the mean intraoperative blood loss with open fixation was found to be 550.00±146.90, whereas for percutaneous fixation it was 85.00±16.70. In a non-randomized trial conducted by Wild et al. [10], it was shown that percutaneous pedicle screw fixation resulted in decreased blood loss (less than 10ml) compared to open surgery in patients with thoracolumbar fractures. The research conducted by Wang Hongwei et al. (13) reported an average blood loss of 83.5±51.8 mL, ranging from 20 mL to 200 mL.

In their study, Ni et al. (12) documented a mean blood loss of 75 mL after percutaneous transpedicular fixation. When comparing open procedures, Wild et al. (10) observed that blood loss during open pedicle screw fixation ranged from 150 to 800 ml, with an average of 350 ml. In their study, Ni et al. (12) documented a mean blood loss of 75 mL during percutaneous pedicle screw fixation.This research reports the mean radiation exposure for open fixation as 1.68±0.44 and for percutaneous fixation as 3.25±0.64.During percutaneous fixation, Wild et al. [10] found that the average radiation exposure was 5.7 minutes. In percutaneous fixation, Schmidt et al. [14] found that the average radiation exposure was 5.99 minutes. Regarding our study, the average length of hospital stay for patients undergoing open fixation was 4.10±0.85 days, with a range of 3-6 days, and for patients undergoing percutaneous fixation was 2.50±0.69 days, with a range of 2-4 days.

In their study, Wang Hong-wei et al. (13) reported that the average duration of hospitalization was 11.1±3.8 days, with a range of 5 to 18 days.When comparing open surgery to percutaneous surgery, Wang Bowen et al. (15) found that the average hospital stay for open surgery was 20.7±5.2 days, whereas for percutaneous surgery it was 9.4±3.2 days. Throughout the duration of our investigation, we did not see any notable issues such as nerve injury, Dural rupture, or serious postoperative infection. The use of a novel three-dimensional computed tomography (CT) navigation system, together with the concurrent utilization of X-ray imaging, and the

insertion of two screws, collectively contribute to the reduction of radiation exposure for medical professionals, healthcare providers, and patients undergoing percutaneous fixation procedures.

Ultimately, it is important to acknowledge that percutaneous systems exhibit a higher cost compared to standard screws. Furthermore, the surgical procedure involved in percutaneous fixation of pedicles presents a significant learning curve, necessitating comprehensive training prior to its regular use.

CONCLUSION

The use of percutaneous transpedicular fixation is a dependable approach that aligns with the fundamental principles of open surgical techniques. This technology allows surgeons to establish a durable internal fixation of the spinal column while simultaneously reducing the extent of tissue damage. In the absence of neurological damage, the use of this method is a feasible approach for the management of unstable thoracolumbar fractures. Moreover, this surgical process has many benefits including a shortened time of the surgery, little blood loss, minimized muscle damage, leading to lower postoperative pain in comparison to traditional open techniques. Additionally, it facilitates reduced hospitalization durations, early mobilization, expedited reintegration into the workforce, and a limited occurrence of complications.

Conflicts of interest:

The authors declare no conflict of interest

Ethics approval

This study was approved by the Faculty of Medicine, Al-Azhar University Research Ethics Committee.

Consent to participate

Each patient was provided a written informed consent for analysis of anonymized data.

Data availability

The data is available upon request of the editorial board.

Funding

No funding was obtained for this study

Personal thanks

Not Applicable

Authorship

M E S selected the patients and reviewed their images and did the interventional procedure, collected, tabulated, and analyzed the data

M E S, M S A, supervised management of the cases, interpreted the patient data and wrote the manuscript.

All authors read and approved the final manuscript.

REFERENCES

1. Alpantaki K, Bano A, Pasku D. Thoracolumbar burst fractures: a systematic review of management. Orthopedics 2010;33:422–9.
2. Wu Y, Chen CH, Tsuang FY, Lin YC, Chiang CJ, Kuo YJ. The stability of long- segment and short-segment fixation for treating severe burst fractures at the thoracolumbar junction in osteoporotic bone: A finite element analysis. PloS one. 2019 Feb 4;14(2):e0211676.
3. Verheyden AP, Spiegl UJ, Ekkerlein H, Gercek E, Hauck S, Josten C, Kandziora F, Katscher S, Kobbe P, Knop C, Lehmann W. Treatment of fractures of the thoracolumbar spine: recommendations of the spine section of the German Society for Orthopaedics and Trauma (DGOU). Global spine journal. 2018;8(2_suppl):34S-45S..
4. Walker CT, Xu DS, Godzik J, Turner JD, Uribe JS, Smith WD. Minimally invasive surgery for thoracolumbar spinal trauma. Annals of translational medicine. 2018 Mar;6(6)..
5. Harris EB, Massey P, Lawrence J, et al. Percutaneous techniques for minimally invasive posterior lumbar fusion. Neurosurg Focus. 2008;25:E12.
6. Kocis J, Kelbl M, Kocis T, Návrat T. Percutaneous versus open pedicle screw fixation for treatment of type A thoracolumbar fractures. European Journal of Trauma and Emergency Surgery. 2020;46(1):147-52.
7. Mobbs RJ, Phan K. History of retractor technologies for percutaneous pedicle screw fixation systems. Orthopaedic surgery. 2016 Feb;8(1):3-10.
8. Tropiano P, Giorgi H, Faure A, Blondel B. Surgical techniques for lumbo-sacral fusion. Orthopaedics& Traumatology: Surgery & Research. 2017;103(1):S151-9.
9. Rajasekaran S, Kanna RM, Shetty AP. Management of thoracolumbar spine trauma: An overview. Indian J Orthop. 2015;49(1):72-82.
10. Wild MH, Glees M, Plieschnegger C, Wenda K. five year follow up examination after purely minimally invasive posterior stabilization of thoracolumbar fractures; A comparison of minimally invasive percutaneous and conventionally open treated patients. Arch orthopedic trauma surg, 2007; 127: 335-43.
11. Merom L, Raz N, Hamud C, Weisz I, Hanani A. Minimally invasive burst fracture fixation in the thoracolumbar region. Orthopedics2009;32:273-8.
12. Ni WF, Huang YX, Chi YL, Xu HZ, Lin Y, Wang XY, et al. Percutaneous pedicle screw fixation for neurologic intact thoracolumbar burst fractures. J Spinal Disord Tech2010;23:530—7.
13. Wang H, Zhou Y, Li C, Liu J, Xiang L. Comparison of open versus percutaneous pedicle screw fixation using the sextant system in the treatment of traumatic thoracolumbar fractures. Clinical spine surgery. 2017;30(3):E239-46.
14. Schmidt OI, Sergej S, Victoria K, Ewald S, Ralf G. Role of early minimal-invasive spine fixation in acute thoracic and lumbar spine trauma. Indian Journal of Orthopaedics, 2007; 41(4):374-380.
15. Wang B, Fan Y, Dong J, Wang H, Wang F, Liu Z, Liu H, Feng Y, Chen F, Huang Z, Chen R. A retrospective study comparing percutaneous and open pedicle screw fixation for thoracolumbar fractures with spinal injuries. Medicine. 2017;96(38).