

## Minimally Invasive (Percutaneous) Pedicle Screws as the Treatment of Choice in Thoracolumbar Spine Fractures

### Małoinwazyjne (przezskórne) techniki stabilizacji przeznasadowej jako postępowanie z wyboru w złamaniach kręgosłupa piersiowego i lędźwiowego

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#### Abstract

**Introduction.** Minimally invasive techniques of transpedicular fusion have become very common and seem to displace classical open techniques. Pedicle screws fusion is the procedure of choice in unstable traumatic lumbar and thoracic spine fractures of.

**Aim.** The aim of the study was to answer whether open techniques are still used in injuries or whether they have been completely replaced by MISS.

**Material and Methods.** The manuscript presents an analysis of patients treated in 2017–2021 in the Department of Neurosurgery, Neurotraumatology and Pediatric Neurosurgery of Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University.

**Results.** Based on the analysis of medical documentation, it was found that every case of traumatic thoracolumbar spine fracture in 2017–2021 was treated using minimally invasive techniques. According to the documentation, the last case of using open surgical technique in the case of trauma was in 2016. It was noted that percutaneous techniques dominated the surgical treatment of thoracolumbar spine fractures and replaced the classic techniques in our department, which are used only, in some cases, in treatment of non-traumatic spondylolisthesis.

**Conclusions.** Therefore, percutaneous techniques are currently the procedure of choice in spine injuries fusion in our hospital. The use of percutaneous techniques reduces the surgical traumatization of tissues (it is important to avoid additional traumatization and blood loss in traumatic patients). It has been pointed out that these procedures are performed by neurosurgeons who, in teaching process, used percutaneous techniques often and now prefer this method. The use of percutaneous techniques has important aspect in the field of neurosurgical nursing, because care of the operated area consists in observing few (4–16) smaller wounds, not one long wound (as in classic techniques), and these wounds are located directly above the titanium screw tips, which must under neurosurgical nurse care.

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**Key Words:** MIS, pedicle screws, percutaneous, spine fracture

#### Streszczenie

**Wstęp.** Techniki minimalnie inwazyjne stabilizacji przeznasadowej stały się bardzo powszechne i wydają się wypierać klasyczne techniki otwarte. Stabilizacja śrubami przeznasadowymi jest postępowaniem z wyboru w przypadku niestabilnych złamań pourazowych kręgosłupa lędźwiowego i piersiowego.

**Cel.** Celem badania była odpowiedź, czy techniki otwarte są nadal stosowane w kontuzjach, czy też zostały całkowicie zastąpione przez MISS.

**Materiał i metody.** W pracy przedstawiona została analiza chorych leczonych w latach 2017–2021 w Klinice Neurochirurgii, Neurotraumatologii i Neurochirurgii Dziecięcej w Collegium Medicum w Bydgoszczy Uniwersytetu Mikołaja Kopernika.

**Wyniki.** Na podstawie dokumentacji medycznej stwierdzono, że w każdym przypadku złamania urazowego w tym okresie zastosowano system małoinwazyjny. Według dokumentacji, ostatni przypadek zastosowania otwartej, klastycznej techniki operacyjnej w przypadku urazu miał miejsce w 2016 r. Zwrócono uwagę, że techniki przeszskórne zdominowały leczenie operacyjne złamań kręgosłupa piersiowo-lędźwiowego i wyparły w naszym ośrodku techniki klasyczne, które stosowane są jedynie, w niektórych przypadkach w leczeniu nieurazowych kręgozmyków.

**Wnioski.** Techniki przeszskórne są więc obecnie postępowaniem z wyboru w stabilizacji urazów kręgosłupa w naszym ośrodku. Zastosowanie technik przeszskórnych zmniejsza chirurgiczną traumatyzację tkanek (a jest to istotne aby nie powodować dodatkowej traumatyzacji i utraty krwi u chorych po urazach). Zwrócono uwagę, że zabiegi te wykonywane są przez neurochirurgów, którzy w procesie swojego nauczania stykali się częściej z technikami przeszskórnymi i obecnie preferują tą metodę. Zastosowanie technik przeszskórnych w urazach kręgosłupa ma istotny aspekt w zakresie pielęgniarstwa neurochirurgicznego, ponieważ pielęgnacja skóry okolicy operowanej polega na obserwacji kilku mniejszych ran (4–16), a nie jednej długiej rany (tak jak w technikach klasycznych), zaś rany te położone są bezpośrednio nad tytanowymi wierzchołkami śrub, co musi budzić czujność z punktu widzenia pielęgniarstwa neurochirurgicznego. (PNN 2022;11(1): 3–7)

**Słowa kluczowe:** MIS, śruby przemasadowe, przeszskórne, złamania kręgosłupa

## Introduction

Percutaneous pedicle screw fusion is now a commonly used surgical technique as an alternative to classic — open techniques. Such stabilization is part of minimally invasive spine surgery (MISS). MISS is thought to be a type of spine surgery using smaller incisions than standard surgery. This often causes less trauma of muscles and other tissues leading to less pain and rapid recovery. MISS (percutaneous) pedicle screw placement was first described by Magerl [1]. Since his description, the use of percutaneous pedicle screws has been expanded to include the treatment of posttraumatic instability, degenerative disease and metastases [1,2]. MISS pedicle screws have theoretical advantages over open surgery, including decreased tissue dissection, less blood loss and less postoperative pain [2,3]. Kim et al. emphasized that percutaneous pedicle screw fixation caused less paraspinal muscle damage than open pedicle screw fixation and had positive effects on postoperative trunk muscle performance [4]. MISS is becoming increasingly widespread in the spine surgery. Foley and Gupta noted that paraspinal tissue trauma in MISS pedicle screw fusion is minimized without compromising the quality of spinal fixation [5].

For these reasons, previously used open techniques of pedicle screws fusion are being replaced by MISS. Currently, neurosurgeons decide to use MISS pedicle screw in all cases of stabilization, including traumatic fractures. We reviewed the pedicle screw fusion procedures at the Department of Neurosurgery, Neurotraumatology and Pediatric Neurosurgery in the Collegium Medicum in Bydgoszcz of the Nicolaus Copernicus University.

The aim of the study was to answer whether open techniques are still used in injuries or whether they have been completely replaced by MISS.

## Material and Methods

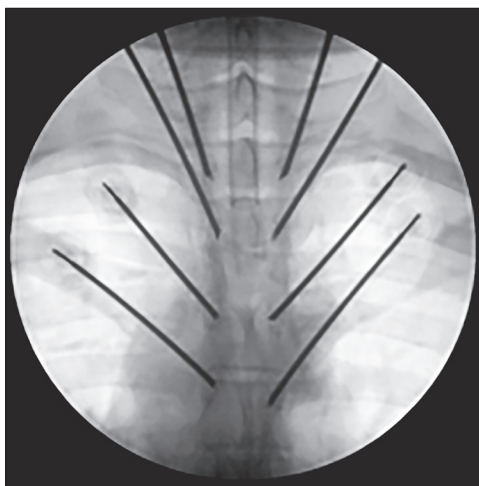
The analysis included patients treated surgically for thoracic and spine fracture in 2017–2021 in Neurosurgical Department of Collegium Medicum in Nicolaus Copernicus University (Bydgoszcz, Poland). We analyzed 95 patients treated surgically for a lumbar fracture (ICD-10: S32.0) and 35 patients treated for a thoracic fracture (ICD-10: S32.0). Among patients with S32.0 there were 65 men with the mean age of 47 years and 30 women with the mean age of 32 years. The age of patients with S32.0 fractures ranged from 18 to 85 years. Among patients with S22.0 there were 20 men with a mean age of 63 years and 15 women with a mean age of 51 years. The analyzed material is presented in Table 1.

**Table 1.** Characteristics of the analyzed patients

Diagnosis	Number	Gender	Mean age	Neurological deficit	Injuries of other organs
				Percent of all patients	
S32.0	65	M	47	21.54	12.31
S32.0	30	F	32	20	13.33
S22.0	20	M	63	30	20
S22.0	15	F	51	26.67	26.67

It was observed that in females, sports injuries and car accidents were more frequent as the, and in males, falls from heights. These observations have not been statistically analyzed and are not the subject of this manuscript.

The treatments were performed using percutaneous MISS techniques. The technique consisted in making surgical incisions, each separately for each screw, and if a laminectomy was required, a separate incision was performed. Spinal needles were then inserted through these



**Figure 1.** Intraoperative X-ray with visible spinal needles

surgical incisions and the Kirschner wires were inserted (Figure 1), then the screws were placed, the rod was fitted and the whole stabilization was fixed. The wound were surgically sutured. Finally, in the operated field in the patient there were as many smaller postoperative wounds as number of inserted screws (Figure 2). The author of the manuscript (ZS) participated in 86.15% of the procedures described, and was the operator of 64.61% of all procedures. Each time the procedure was attended by a resident or specialist in neurosurgery with experience of less than 10 years. Such specialists were trained with the MISS pedicle screw, and perfected these techniques during courses and internships.

This is important from the point of view of neurosurgical nursing as there is a need to nurse small wounds with titanium screw tips underneath. According to the standards of operative techniques, the thoracolumbar fascia should be tightly sutured to minimize the risk of exposure of the screw to the skin surface. Therefore, careful observation of the wound is important from the point of view of the neurosurgical nurse.

## Results

All 130 neurosurgical patients with both S32.0 and S22.0 fractures were operated using MISS technique. No pedicle screw fusion performer by the classical open technique was observed. When reviewing the medical documentation, it was noted that the last such procedure in a patient with S32.0 was performed a year earlier in 2016 (this period did not include our analysis, because the aim of the study was to evaluate the five-year period 2017–2021). On the basis of the Student's t-test, it was found that both in S32.0 and S22.0 group, the mean age of males was significantly higher than females (Student's t-test separately for S32.0 and S22.0). However surgical



**Figure 2.** Postoperative wounds over tips of 4 screws

personnel composition was not subjected to statistical analysis, because it would be methodologically impossible, in the opinion of the authors, residents and young specialists (often performing posttraumatic surgeries including spine fractures) prefer MISS rather than an open technique.

## Discussion

The widespread use of MISS pedicle screws fusion has been described by many authors. Ringel et al. assessed the feasibility and safety of percutaneous posterior pedicle screw fixation for instabilities of the thoracic and lumbar spine, using standard instruments designed for the open approach and fluoroscopy [6]. In his study, surgical treatment of 104 patients with total number of 488 pedicle screws was described. Ringel et al. noted that percutaneous internal pedicle screw fixation using standard instruments is feasible and safe for posterior stabilization of the thoracic and lumbar spine [6]. According to Ringel et al. MISS technique is straightforward alternative for open approaches or minimally invasive ones using navigation in conjunction with customized instruments. Accuracy of screw placement is similar to that reported for other techniques [6].

Fassett and Brodke noted that lumbar pedicle screw fixation is a common procedure performed in spinal surgery. They emphasized that in traditional open approaches, extensive midline exposure extends above and below the instrumented levels allowing lateral retraction of the soft tissues to visualize the pedicle screw entry points at the intersection of the transverse process and facet complexes [7]. MISS lumbar pedicle screws may be used to treat degenerative disc disease, spondylolisthesis, and spinal trauma. Fassett and Brodke emphasized that popularity of minimally invasive spinal arthrodesis

procedures is growing, and percutaneous pedicle screws are often used to minimize soft — tissue trauma [7].

Ni et al. evaluated the efficacy and safety of percutaneous pedicle screw fixation for thoracolumbar AO type A3 fractures with a specially designed surgical instrument system [8]. He noted that MISS is becoming increasingly widespread in the spine surgery. According to Ni these procedures have been proved as relatively safe and a minimally invasive approach for the management of thoracolumbar burst fracture without neurologic deficit [8]. This is consistent with our observations, although supplementing Ni conclusions, we state that also in the case of a neurological deficit (12.31–26.67% of the analyzed patients), MISS is also an optimal surgical technique.

Nimjee et al. evaluated the safety of percutaneous pedicle screw placement in the thoracic and thoracolumbar spine without image-navigation. He concluded that thoracic and thoracolumbar percutaneous pedicle screw placement can be performed safely and accurately without image-navigation [9]. It is consistent with our surgical technique and habits, because using MISS pedicle fusion in all analyzed patients we did not use navigation, but only intraoperative fluoroscopy.

Gong et al. compared the clinical effects of minimally invasive percutaneous pedicle screws osteosynthesis and open surgery on the repair of thoracolumbar vertebra fracture. He observed that both MISS and traditional surgery effectively alleviated the pain ( $P < 0.05$ ), which was more significant in MISS group ( $P < 0.05$ ) [10]. The post-operative inflammatory indexes, CRP and CK levels, of both groups were higher compared to the pre-operation ( $P < 0.05$ ), which was more significant in open surgery group ( $P < 0.05$ ) [10]. Gong concluded that the effect of minimally invasive percutaneous pedicle screws osteosynthesis is similar to open surgery, however, the MISS technique has the advantages of small trauma, less bleeding, short duration of operation, rapid post-operative recovery, light pain, less economic cost, and better aesthetic effect and is therefore worthy of clinical promotion [10]. Gong's conclusions are important from the point of view of neurosurgical nursing.

## Conclusions

Due to lower tissue trauma, increasing popularity and personal preferences of neurosurgeons, percutaneous pedicle screw fusion (minimally invasive) has become the surgical technique of choice in the treatment of traumatic thoracolumbar spine fractures. It is also important from the point of view of neurosurgical nursing, because it indicates the nurse the proper management of postoperative wounds, which in this technique have their own specificity (they are short,

multiple, the tips of the screws are in the projection of wounds).

## Implications for Nursing Practice

The presented follow-up studies in the field of neurosurgical nurse. Due to the use of percutaneous injuries, skin care in the area operated using guided techniques of several experts (4–16), not one group (as in the classic techniques), and these wounds are located directly above the titanium tips, which must be vigilant care.

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