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RADICULAR SYMPTOMS ASSOCIATED WITH EXTRAPEDICULAR SCREW PLACEMENT

SINTOMAS RADICULARES ASSOCIADOS COM A COLOCAÇÃO EXTRAPEDICULAR DE PARAFUSOS

SÍNTOMAS RADICULARES ASOCIADOS A LA COLOCACIÓN DE TORNILLOS EXTRAPEDICULARES

Jorge Alberto Pérez Terrazas[1], Daniel Sebastián Rivas Toledano[1], Arturo Rivera Galindo[2], Erick Frias Hernandez[3], Jaime Antonio Sanchez Sandoval[2], Gilberto Valadez Cabrera[2], Avelino Aguilar[3]

1. Hospital General de México, Spine Surgery Department, Mexico City, Mexico.
2. Hospital Pemex Sur de Alta Especialidad, Mexico City, Mexico.
3. Hospital Angeles Metropolitano, Spine Surgery, Mexico City, Mexico.

ABSTRACT

Objective: Transpedicular fixation has rapidly evolved over the last 100 years. A common complication is screw misplacement which can lead to neurological deficits, vascular damage, or organ perforation. We intend to assess the correlation between screw misplacement and radicular symptoms through the Gertzbein scale. Methods: We conducted an observational longitudinal retrospective study on patients who underwent free-hand lumbar instrumentation surgery with fluoroscopy assistance. The patients were evaluated with postoperative CT scans, and screw positions were classified with the Gertzbein scale. Results: The initial sample included 99 patients who underwent surgery. Of the 317 screws placed, 201 did not show cortical damage, 105 screws exhibited variable invasion, and 11 screws displayed severe invasion. 96.5% screws were placed in the safe zone, with 8.6% of patients (n=5.0) exhibiting transitory weakness. 3.47% of screws (n=11) with severe invasion were seen in 7 patients of which two patients suffered from motor deficient and persistent radicular pain. Conclusion: It is of the utmost importance to pay attention to the precise insertion of the screws to minimize the risk of radicular manifestations. We recommend performing control CT scans after the procedure to ensure the correct insertion of the screws, and in case of finding a screw in a no-safe zone or Getsbein 3 position, considering screw repositioning due to high-risk neurologic damage is highly encouraged. ***Level of Evidence II; Observational Retrospective Study.***

Keywords: Pedicle Screws; Spine; Surgical Fixation Devices; Radiculopathy.

RESUMO

Objetivo: A fixação transpedicular evoluiu rapidamente nos últimos 100 anos, porém o deslocamento do parafuso é uma complicação comum que pode resultar em déficits neurológicos ou danos vasculares. Pretendemos correlacionar o deslocamento do parafuso com sintomas radiculares usando a escala de Gertzbein. Métodos: Conduzimos um estudo retrospectivo longitudinal observacional em pacientes submetidos à cirurgia de instrumentação lombar à mão livre com assistência de fluoroscopia. Os pacientes foram avaliados com tomografia computadorizada pós-operatória e as posições dos parafusos foram classificadas com a escala de Gertzbein. Resultados: A amostra inicial incluiu 99 pacientes. Dos 317 parafusos colocados, 201 não mostraram danos corticais, 105 exibiram invasão variável e 11 invasão severa. 96,5% dos parafusos foram colocados na zona segura, com 8,6% dos pacientes apresentando fraqueza transitório. 3,47% dos parafusos com invasão severa foram observados em 7 pacientes, dos quais 2 sofreram de deficiência motora e dor radicular persistente. Conclusão: É crucial prestar atenção à inserção precisa dos parafusos para minimizar o risco de manifestações radiculares. Recomendamos tomografias de controle para garantir a correta inserção dos parafusos e, se necessário, reposicionamento devido ao alto risco de dano neurológico. ***Nível de Evidência II; Estudo Observacional Retrospectivo.***

Descritores*: Parafusos Pediculares; Coluna Vertebral; Dispositivos de Fixação Cirúrgica; Radiculopatia.*

RESUMEN

Objetivo: La fijación transpedicular ha evolucionado en los últimos 100 años. Una complicación común es el desplazamiento de tornillos, causante de déficits neurológicos o daños vasculares. Buscamos correlacionar el desplazamiento con síntomas radiculares mediante la escala de Gertzbein. Métodos: Se realizó un estudio observacional longitudinal retrospectivo de pacientes sometidos a cirugía de instrumentación lumbar a mano alzada asistida por fluoroscopia. Los pacientes fueron evaluados con tomografía computarizada postoperatoria y las posiciones de los tornillos se clasificaron con la escala de Gertzbein. Resultados: La muestra inicial incluyó 99 pacientes. De los 317 tornillos colocados, 201 no mostraron daño cortical, 105 mostraron invasión variable y 11 mostraron invasión severa. El 96,5% de los tornillos se colocaron en la zona segura, y el 8,6% de los pacientes mostraron debilidad transitoria. Se observó un 3,47% de tornillos con invasión grave en 7 pacientes, 2 de los cuales sufrieron discapacidad motora y dolor radicular persistente. Conclusión: Es crucial prestar

Study conducted by the Hospital de Alta Especialidad PEMEX, Mexico City, Mexico.
Correspondence: Jorge Alberto Pérez Terrazas. 148, Dr. Balmis Street, Doctores, Cuauhtémoc, Mexico City, Mexico. 06720. perezterrazas.ja@gmail.com

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atención a la inserción precisa de los tornillos para minimizar el riesgo de manifestaciones radiculares. Recomendamos la realización de tomografías de control para asegurar la correcta inserción de los tornillos y, en caso necesario, su recolocación debido al elevado riesgo de daño neurológico. ***Nivel de Evidencia II; Estudio Observacional Retrospectivo.***

Descriptores: *Tornillos Pediculares; Columna Vertebral; Dispositivos de Fijación Quirúrgicos; Radiculopatía.*

INTRODUCTION

Transpedicular vertebral fixation can be applied to a wide range of spinal conditions, including congenital deformities such as scoliosis or hyperkyphosis, vertebral fractures, spinal tumors, and degenerative, infectious, and vascular disorders.[1,2]

Over the last 100 years, spine surgery has undergone a remarkable transformation in medicine. One of the earliest successful internal fixation techniques was developed by Hadra in 1981, with a simple silver wire loop in a figure-eight shape around the spinous processes.[3] At Stanford University Medical School, King was the first surgeon to employ vertebral screw fixation, promptly achieving firm stabilization.[4] In 1953, Roy-Camille introduced the concept of transpedicular screws for osteosynthesis. This approach gained popularity and has become a fundamental technique in modern spinal fixation.[5] Nowadays, among the surgical modalities employed in addressing spinal pathologies, posterior transpedicular column instrumentation utilizing the free hand technique emerges as a globally predominant approach.[6]

The advantages of this modality include reduced radiation exposure, shorter surgical time, and the associated benefits such as a lower risk of infection and bleeding.[7,8] Unfortunately, the results can vary depending on the surgeon's experience, and the placement of transpedicular screws may result in different space violations. Nevertheless, proper screw placement rate within the pedicle is reported to range between 71.9% to 98.3%.[9-11]

Screw misplacements or violations can be grouped into medial breach with potential spinal cord injury, inferior breach with nerve root injury, or lateral breach anterior vital structure injury, including vascular or organ affectation.[12] Screw malposition has an overall incidence of 0%-42%, being the most common complication reported. Associated complications, such as neurological, visceral, or vascular damage, are much more serious but infrequent.[13] Postoperative evaluation of screw malposition is routinely assessed with CT scan and various grading systems, the most common being the 2 mm increment grading system.[14,15]

Screw misplacement can lead to re-operation, which is mostly determined by a patient's symptoms, such as radicular pain, motor or sensory dysfunction, and the surgeon's subjective perception. Currently, there is no systematic assessment method, with reports mentioning re-operation even in patients with no symptoms.[16,17]

In this study we intend to conduct an assessment to discern any correlation between extrapedicular screw placement and the manifestation of radicular symptoms. Utilizing the Gertzbein scale, we aim to categorize those extrapedicular screws responsible for provoking radicular symptoms, thereby necessitating subsequent surgical intervention. Secondary end points of this study include describing the most common extrapedicular position, the lumbar level with the highest screw placement failures, the most frequent surgical indication for lumbar instrumentation, and the number of patients with improper transpedicular screw placement requiring re-intervention. The insights garnered from this evaluation may serve to establish standardized protocols for future surgical procedures.

MATERIALS AND METHODS

A retrospective, observational, analytical, longitudinal study was conducted on patients who underwent lumbar-sacral instrumentation surgery using a free hand technique with fluoroscopy assistance at a high-specialty central hospital in Mexico City, under the orthopedic and traumatology department's care, from January 2011 to February 2019. Postoperative tomography was performed, and the placement of transpedicular screws was classified using the Gertzbein scale. (Table 1)

Table 1. Gertzbein & Robbins intrapedicular score.[18,19]

Score	Screw Deviation	Comments
A	0 mm	Fully intrapedicular position without cortex breach
B	<2mm	Exceeding the cortex
C	2-4mm	
D	2-6mm	
E	>6mm	

Subsequently, the electronic medical records of the patients were reviewed, with a follow-up period ranging from 2 months to 2 years, to detect the presence of postoperative radicular symptoms or neurological sequelae that were not present before the surgery. Additionally, it was documented whether there was a need for a surgical reintervention.

The sample size was determined by convenience. The study included patients who had undergone lumbar instrumentation surgery using a hands-free technique with fluoroscopy assistance and who had postoperative computed tomography along with adequate patient follow-up. Exclusion criteria encompassed patients who had undergone surgery at other institutions, those operated on using a different technique (such as evoked potentials, percutaneous techniques, etc.), patients who had previous lumbar instrumentation and were re-instrumented, individuals without postoperative control tomography or cases where visualization was unsuccessful, and instances of follow-up failure.

For the eligible patients, data were collected and organized, specifying the manipulated vertebral levels and the degree of cortical perforation according to the Gertzbein scale.

RESULTS

Ninety-nine patients underwent posterior instrumentation surgery, performed by six spine surgeons, from August 2011 to April 2019. 34 patients were excluded from the study due to the absence of postoperative control tomography or issues related to visualization. One patient had a T11 fracture and preoperative ASIA C spinal cord injury, and four patients had been operated on using different techniques. The study included 60 patients who met the inclusion criteria, consisting of 23 males (38.3%) and 37 females (61.6%), with a total of 317 transpedicular screws (Figure 1). The age range varied from 38 to 79 years, with an average age of 58.35. The surgical indications were degenerative changes in 49 patients (71.01%), trauma in 8 patients (11.59%), and infection in 3 patients (4.34%). Only the lumbar screws were considered in this study for patients who underwent dorsolumbar instrumentation.

Of the 317 screws placed, 201 screws (63.4%) were within the pedicle without cortical damage (Gertzbein 0), 81 screws (25.55%) showed minimal invasion, 24 screws (7.57%) displayed moderate invasion, and 11 screws (3.47%) exhibited severe invasion. The screws with placement in a non-safe zone (Gertzbein classification 3) had an incidence of 2.5%.

A total of 306 screws (96.5%) were placed in the safe zone, and among them, 36 patients (216 screws - 68.13%) experienced no radicular complications. Twelve patients (60 screws - 18.92%) presented transient muscular weakness or paresthesia in the pelvic limbs, and five patients (30 screws - 9.46%) suffered from Transitory weakness or paresthesia.

Eleven screws (3.47%) resulted in severe transpedicular invasion in 7 patients. Among them, one patient with one screw (0.31%) did not experience any radicular symptoms, six screws (1.89%) in three

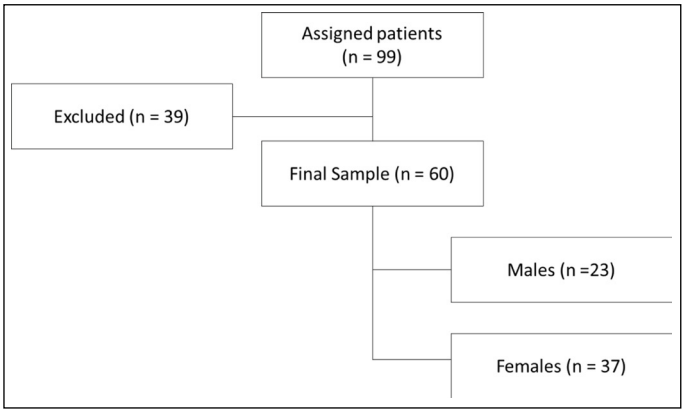

Figure 1. Information on participant flow and sample selection.

patients exhibited transient paresthesia in the pelvic limbs, and four screws (1.26%) in three patients presented permanent radicular symptoms. Of these, two patients (three screws) had motor deficits, and one patient (one screw) had persistent radicular pain.

Out of the 317 screws, five screws (1.57%) had to be repositioned in four patients, including two screws (0.63%) with moderate invasion and three screws (0.94%) with severe invasion. Screw removal was indicated due to persistent radicular pain in 3 patients and pain with neurological deficits in 1 patient.

DISCUSSION

The study included 60 patients, of which 38.3% were male and 61.6% were female, with a median age of 58.35 years, most of them requiring intervention due to degenerative pathologies.

Three hundred seventeen screws were inserted, with 96.5% positioned in the safe zone, suggesting a high degree of precision during insertion. Screws located in no safe zones (Gertzbein 3) had an incidence of 2.5%, correlating with low frequencies of presentation. Most patients didn't show significant clinical outcomes for radicular damage. In a systematic review performed by Gelalis Et. Al, the percentage of screws contained within the pedicle was reported to range from 69-94%, while accuracy in screws placed with the aid of fluoroscopy ranged from 28-85%, showing similar results compared to our study. Likewise, it was reported that the percentage of accurate screw placement with CT navigation reached 89-100%, demonstrating superior results. Screw malposition with a violation greater than 4mm exhibited an incidence of 0-40% when utilizing fluoroscopy-free hand placement.[20] Another systematic review performed by Matur et al., reported that both robotic and navigated screw placement were associated with greater accuracy (OR 2.66, CI = 1.24-5.72, p=.01), lower risk of facet violation (RR 0.09, CI 1.24-5.72, p <.02) but no differences in nerve root injury (RR 0.50, CI 0.11-2.30, p = .37) or the need for reoperation (RR 0.28, CI 0.07, p=.07) compared to fluoroscopy free hand screw placement.[21]

Muscular weakness or transitory paresthesia in lower extremities were observed in 18.92% of all patients while permanent paresis or paresthesia occurred in 9.46% of cases. Clinical symptoms presented with more prominence in patients with severe invasion; nevertheless, these events were infrequent. Only one patient with severe invasion maintained a symptomless course. A retrospective study with 85 patients reported an accuracy of 95.12% with free-hand screw placement, with only two patients developing radicular pain. In comparison, another study with 50 patients and 93% accuracy reported the same number of cases with mild postoperative sequelae.[22,23]

The need to relocate screws was fairly low, with a rate of 1.57% of all screws. Indications for reintervention included radicular pain without improvement, non-radicular pain, and motor deficits. In a retrospective study with 10,754 patients conducted by Odate et al., the rate of reintervention was .17% due to neurological symptoms, screw contact with vessels, and suboptimal bone purchase, neurological being symptoms the most prevalent cause.[24]

CONCLUSIONS

The results of this study suggest that posterior instrumentation with transpedicular screws is a safe and efficient approach when treating a wide variety of spinal pathologies. Nevertheless, it is of the utmost importance to pay attention to the precise insertion of the screws to minimize the risk of radicular manifestations, especially when severe invasion is noted.

We recommend performing control CT scans after the procedure to ensure the correct insertion of the screws. In case of finding a screw in a no-safe zone or Getsbein 3 position, considering screw repositioning due to high-risk neurologic damage is highly encouraged. Gertzbein classification continues to be a major reference with great impact in evaluating screw insertion and position quality.

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