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Research Article

Evaluating the Necessity of Screw Replacement in Sacral Bone Loosening: A Minimally Invasive Approach for Treatment with Local Anesthesia

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Abstract

Background This study aimed to investigate a minimally invasive approach to address the issue of bone loosening in patients who have undergone posterior spinal fusion surgery. If left untreated, sacral bone loosening can result in nerve damage, reduced mobility, and chronic pain. The standard surgical treatment involves replacing the loosened screw with a larger one, requiring significant surgical intervention and complete instrument disassembly. The use of polymethylmethacrylate (PMMA) to increase the strength of the vertebral body was also described, but the results were contradictory. We aim to evaluate the efficacy of filling just only the gap between bone and screw instead of the vertebral body.

Methods This study included patients who had undergone posterior transpedicular stabilization but showed signs of sacral bone loosening in follow-up. The gap between the screw and the bone was targeted instead of the vertebral body and filled using PMMA. The procedure was performed under local anesthesia and fluoroscopy, and the preoperative and postoperative visual analog scale (VAS) scores were compared at 1, 3, and 12 months after the procedure.

Results The study included 17 patients who underwent 28 procedures, with 11 patients receiving bilateral and 6 receiving unilateral approaches. The results showed a significant decrease in postoperative VAS scores compared to the preoperative scores, indicating reduced pain and discomfort. PMMA, as a bone filler, has been reported to provide good stability and support to the bone-implant interface, thereby reducing the risk of screw loosening and improving the outcome of spinal fusion surgery.

Conclusion In conclusion, the study demonstrates the efficacy of a minimally invasive approach using PMMA to treat sacral bone loosening in patients who have undergone posterior spinal fusion surgery. The procedure is safe, minimally invasive, and provides significant pain relief, making it a viable alternative to traditional surgical methods.

Keywords

- bone loosening
- screw loosening
- polymethylmethacrylate
- fusion insufficiency

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Introduction

Spinal instrumentation is widely used for treating various spine conditions, including degenerative diseases, trauma, and tumors. In adult spinal deformities, fixation is critical to maintain proper vertebral alignment and achieve optimal bone fusion.[1–3] The approach for lumbosacral fixation is individualized to each patient and may comprise various techniques such as iliac screws, S1 and S2 pedicle screws, S2 alar screws, and L5/S1 interbody fusion.[4] However, postoperative follow-up may reveal complications such as instrument breakage, dislocation, or bone fractures.[5] One of the most commonly encountered issues without trauma is bone loosening and loss of screw fixation.[1] Despite advancements in surgical techniques and instruments, inadequate solid fixation remains challenging, especially in osteoporosis or long-term fixation cases. These weaknesses can result in a realignment of the vertebral column, negatively impact sagittal balance, and lead to poor clinical outcomes.[6] Revision surgery may become necessary, increasing morbidity and cost and decreasing patient satisfaction.[7] In situations where instrumentation-related insufficiencies need to be addressed, particularly in cases of fractures associated with osteoporosis or tumors, minimally invasive methods are utilized, such as filling the vertebral body with cement prior to the insertion of pedicular screws.[7–13]

Bone loosening around the screw can cause instability in the system and severe pain for the patient. Filling the corpus with cement can increase bone density but does not address the loosened screw. This study aims to evaluate the efficacy of a percutaneous screw fixation technique that uses cement application between the loosened screw and bone in our patient population. The results of this technique will be presented and analyzed.

Materials and Methods

The present study included patients who had undergone posterior transpedicular stabilization in our hospital and reported recurring symptoms during their follow-up. Radiographs and spinal computed tomography (CT) scans were obtained for all patients to assess the sagittal balance and the status of the screws. These images were reviewed by a single radiologist who defined a radiolucent area (circumference greater than 1 mm) around the screw as evidence of screw/bone loosening. Only patients with sacral screw/bone loosening were included in the study. Patients with instability due to screw breakage, bone fracture, or adjacent segment pathologies without evidence of screw/bone loosening were excluded. Informed consent was obtained from all participants.

Surgical Procedure

The patients were positioned prone on the operating table, and the procedure was performed under sterile conditions with the administration of local anesthesia and sedation. A single dose of prophylactic intravenous antibiotic (cefazolin, 2 g) was administered 1 hour before the procedure. Fluoroscopy guided the procedure, with anteroposterior and lateral images obtained. In cases where patient anatomy made visualization difficult, oblique images were used. The insertion site was targeted approximately 2 cm lateral to the S1 pedicle, and the area was anesthetized with a lidocaine injection. The 10-gauge stylet was guided to the S1 screw at an angle of approximately 45 degrees lateral to the S1 pedicle, and the meeting of the stylet and pedicle screw was confirmed with fluoroscopy (►**Fig. 1**). The presence of the needle in the space between the screw and bone was confirmed by injecting radiopaque material. Polymethylmethacrylate (PMMA) was then injected around the screw and monitored with real-time fluoroscopy, and the filling of the gap with PMMA was confirmed (►**Fig. 2**). The cannula was removed, and the patients were transferred to a bed in stable condition.

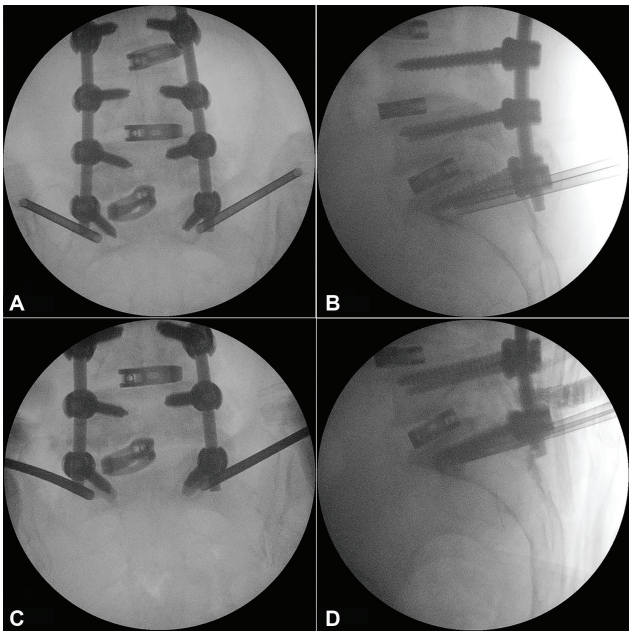

Fig. 1 Fluoroscopy images of the procedure. (**A**) Anteroposterior view of the loosened S1 screw before polymethylmethacrylate (PMMA) augmentation. The cannula was placed into the gap between the bone and the screw. (**B**) Lateral view of the cannula. (**C, D**) The PMMA was augmented into the gap, and the procedure was observed in real time with coronal and sagittal fluoroscopy images.

Follow-Up

Patients were mobilized on the same day after the sedative effect had worn off. The visual analog scale (VAS) score was used to compare the patients' low back pain before and after the operation. X-ray and CT scans were performed at 1, 3, and 12 months postoperatively to assess for screw loosening. The VAS scores were compared at these time points.

Statistics

The Mann-Whitney U test was utilized to compare the preoperative VAS scores with the postoperative VAS scores on the 1st day, 1st month, 3rd month, and 12th month. Statistical analysis was performed using SPSS version 13.0 (SPSS Inc., Chicago, Illinois, United States), and a *p*-value less than 0.05 was considered statistically significant.

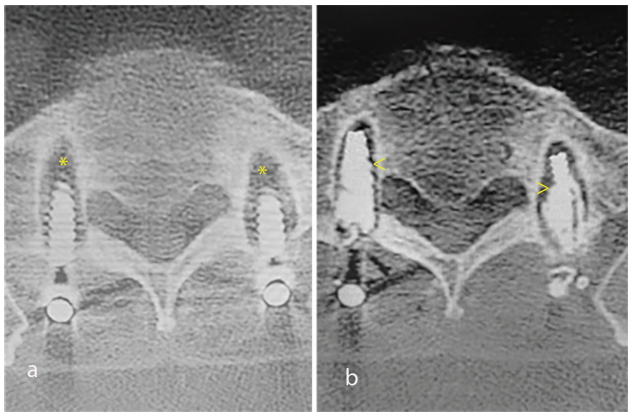

Fig. 2 The computed tomography scans were used to evaluate if the proper filling was acquired (*bone loosening around the screw; > <the gap was filled with polymethylmethacrylate).

Results

All patients who underwent posterior stabilization had a painless period after their first surgery. However, the sacral pain recurred after a while (28 ± 7 mounts). A total of 28 surgical procedures were conducted on 17 patients, with 11 receiving bilateral procedures and 6 receiving unilateral procedures. One patient underwent a procedure that was eventually abandoned due to the adverse effects of the sedation medication. The study population comprised 8 female and 9 male patients, with a mean age of 57 ± 2 years. Four patients were classified as overweight, five were underweight, and eight were of average weight. The preoperative mean VAS score was 7 ± 2, with pain being the most common complaint. The VAS scores significantly decreased on the 1st postoperative day ($VAS = 3 \pm 1$, $p < 0.05$) and continued to decline considerably during the 1st, 3rd, and 12th-month follow-up visits. No significant changes were observed in the follow-up VAS scores (►**Fig. 3**).

Discussion

The loosening of screws is a critical issue that patients who have undergone spinal fusion surgery frequently encounter. Such loosening can cause pain, particularly during movement. It may also put a load on the other healthy segments of the spine, leading to further loosening, protrusion, or fractures over time.[1] The incidence of sacral screw loosening after long-segment spinal fusion is relatively high, ranging from 7.5 to 52%.[14] Low bone density and quality are the most significant factors contributing to screw loosening, with osteopenia caused by aging, hormonal factors, and disuse after surgery being the major contributing factors.[15,16] Other significant factors include bone and screw surface deformations, high static stress, and loading. High pelvic incidence, failure to correct lumbar lordosis, and postoperative sagittal imbalance have also been identified as risk factors for lumbosacral fixation failure and bone loosening.[14,17]

Numerous strategies have been suggested to prevent screw loosening, including expandable screws, thicker screws, and cannulated screws. Despite these efforts, screw loosening continues to be a challenge. Surgical revision is often required, where the loosened screw is replaced with a larger diameter screw, and additional screws and rods are added if necessary. While filling the bone loss area with PMMA and adding a screw to the same site has gained popularity, it still requires general anesthesia and disassembly and reattachment of the entire system.[6,15]

Minimally invasive options are preferable for resolving instrumentation failure. Vertebral cement reinforcement has been used to treat painful osteoporotic and tumor-associated

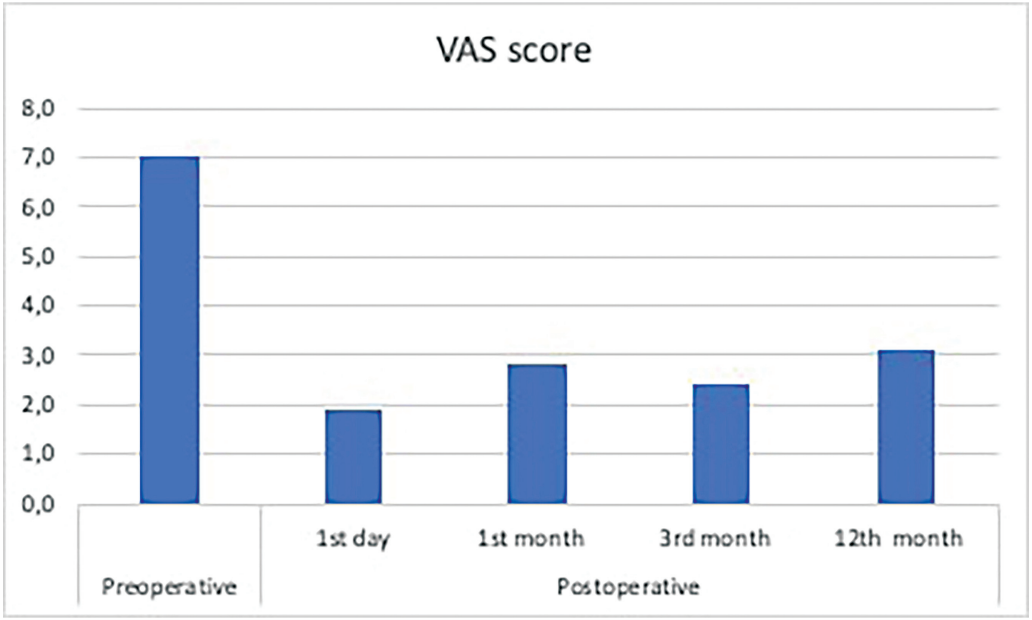

Fig. 3 The graph illustrates the significant decrease between the preoperative and postoperative visual analog scale (VAS) scores. There was no significant change between the follow-up VAS scores.

compression fractures.[7,11] Several studies have described using PMMA during primary surgery to reinforce pedicular screws.[5,8–10,12]

This study aimed to prevent screw movement by filling the space between the loosened screw and the bone with PMMA. The filled cavity was found to simulate a surgical intervention, with the thickness of the screw being equivalent. Results indicated that the filled cavity, acting like a thick screw, prevented screw movement and reduced patient pain. The advantage of this method was that it did not require general anesthesia and was performed percutaneously without significant surgical intervention. Additionally, since there were no issues with the proximal screws, there was no need to disassemble the entire system to replace just the distal screw. This approach offers advantages over surgical revision, including shorter hospital stays and a lower impact on the patient's work capacity. All patients could mobilize, were discharged from the hospital on the same day, and could return to their normal activities on the 3rd day.

Conclusion

Sacral screws in posterior instrumentation often result in bone loosening, which generates discomfort for the patient due to the screw movement within the space between the bone and the screw. Percutaneous intervention utilizing cement filling under fluoroscopy guidance and local anesthesia can mitigate screw movement and alleviate patient pain. This approach is more favorable than revision surgery, as it entails fewer surgical risks, shorter hospital stays, and higher patient satisfaction in long-term follow-up evaluations.

Note

The authors certify that the work presented here is genuine, original, and not submitted anywhere, in part or whole.

Informed Consent

Informed consent has been obtained from all individuals included in this study. The patients' identities have been adequately anonymized.

Ethical Approval Statement

Research involving human subjects complied with all relevant national regulations and institutional policies, is in accordance with the tenets of the Helsinki Declaration (as amended in 2013), and has been approved by the authors' Institutional Ethical Committee (25403353-050.99-E.76043).

Authors' Contribution

M.B. and S.E. designed the study, collected and interpreted the data, and wrote the manuscript. Hakan Millet collected the data and performed statistical analyses.

Conflict of Interest

None declared.

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