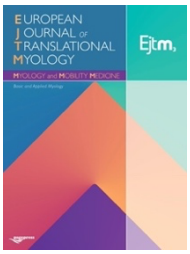
European Journal of Translational Myology



pISSN: 2037-7452 eISSN: 2037-7460

https://www.pagepressjournals.org/index.php/bam/index

Eur J TranslMyol 2024 [Online ahead of print]

TocitethisArticle:

Kapetanakis S, Chaniotakis C, Zavridis P, et al. **Vertebroplasty and kyphoplasty in the management of osteoporotic vertebral compression fractures in elderly individuals: evaluation of the health- related quality of life.** *Eur J Trans Myol*doi: 10.4081/ejtm.2024.12274

Vertebroplasty and kyphoplasty in the management of osteoporotic vertebral compression fractures in elderly individuals: evaluation of the health-related quality of life

Stylianos Kapetanakis,[1,2] Constantinos Chaniotakis,[1] Periklis Zavridis,[3] Periklis Kopsidas,[1] Sotirios Apostolakis,[1] Nikolaos Gkantsinikoudis[1]

[1]Spine Department and Deformities, Interbalkan European Medical Center, Thessaloniki, Greece; [2]Department of Minimally Invasive and Endoscopic Spine Surgery, Athens Medical Center, Athens, Greece; [3]Cyprus Pain Clinic, Egkomi, Cyprus

Abstract

Aim of this study is to investigate the safety, efficacy and impact on Health-Related Quality of Life (HRQoL) of Vertebroplasty (VP) and Kyphoplasty (KP) in the management of Osteoporotic Vertebral Compression Fractures (OVCFs) in elderly individuals. VP and KP represent Minimally Invasive Vertebral Augmentation (MIVA) procedures that are increasingly implemented for surgical treatment of OVCFs in recent years. These interventions have been associated with minimal traumatization and intraoperative hemorrhage, considerable analgesic effect and rapid postoperative recovery. Seventy-seven (77) consecutive individuals with OVCFs were subjected to VP/KP and recruited in this prospectively designed non-randomized study. Clinical evaluation was performed preoperatively and postoperatively at particular chronic intervals at 1, 6 weeks and at 3, 6, 12 months and 2 years. Assessment was conducted via the standardized Visual Analogue Scale (VAS) and Short-Form 36 (SF-36) Medical Health Survey Questionnaire for pain and HRQoL, respectively. No perioperative complications were observed. All studied indices were demonstrated to present a statistically significant amelioration following overall analysis. Pain intensity measured by the VAS score was depicted to be significantly reduced during the first 3 months, but continuous improvement of all indices of SF-36 and VAS was demonstrated to reach a plateau at 6 months, featuring no further clinical improvement.VP and KP represent safe and efficient options for interventional treatment of OVCFs in elderly and oldest-old patients, improving self-reported symptoms of pain as well as overall HRQoL.

Key words: minimally invasive vertebral augmentation; vertebroplasty; kyphoplasty; osteoporotic vertebral compression fractures; health-related quality of life.

Since the World Health Organization (WHO) definition in 1993 describing osteoporosis as a systemic skeletal disease that is related to bone mass loss, there has been great effort towards the development of novel, minimally invasive therapeutic interventions.[1-2] Aggregated evidence from pre-clinical and clinical studies have resulted in a better description of this clinical condition.[3] Osteoporosis occurs when bone development is slower than its degradation causing instability of the trabecular bone tissue, a process closely associated with fracture rate. Moreover, it has been stated that a substantial loss of approximately 40% of the bone mass is present in more than 50% of cases of insufficiency fractures.[4] The Osteoporotic Vertebral Compression Fractures (OVCFs) have been demonstrated to feature a ratio of 30%-50% in individuals older than 50 years old. Considering the ever-growing longevity of the population worldwide, the incidence of OVCFs is expected to rise in the future.[5]

Existing treatment modalities for the management of OVCFs are either conservative or interventional.[6-7] Conservative treatment includes activity modification, analgesics, and exercises aimed at strengthening spine muscular stabilizers. However, failure of conservative management in the context of specific clinical manifestations necessitates interventional management.[4,8] Minimally Invasive Augmentation (MIVA) procedures, principally represented by Vertebroplasty (VP) and Kyphoplasty (KP), represent novel and atraumatic procedures that gain constant ground for interventional management of OVCFs in the field of spine surgery in recent years. These techniques aim to restore the mechanical strength and stability of the vertebral body and to adequately reduce the reported pain whilst also preventing new fractures, being associated with minimal invasiveness and considerable clinical effectiveness in recent literature reports.[3,9] However, safety and efficacy of MIVA procedures in conjunction with postoperative Health-Related Quality of Life (HRQoL) of operated individuals has not been studied in the ever-aging population yet.

This study aims to evaluate the safety, effectiveness and HRQoL alterations post VP and KP in elderly individuals with OVCFs. The demographically authentic national perspective, in conjunction with the comparative analysis of the studied indices, underscores the originality of this investigation.

Materials and Methods

Study population and approvals

All enrolled patients in this study were diagnosed with OVCFs, meeting all current indications for MIVA procedures. All patients were referred to the same senior spine surgeon and all procedures were performed in the same tertiary center. Patients were fully informed about the principles and aims of this study, agreeing to participate by providing informed written consent. Protection of

distinct patients' rights as well as privacy was strictly warranted during study performance. The study protocol was approved by the Institutional Review Board of involved hospital (Interbalkan European Medical Center, Thessaloniki, Greece - Approval Number: 29.09.2018). All aspects of this study were in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans, as defined in 1975 and as revised in 2013.

The study inclusion criteria were: i) elderly and oldest-old patients diagnosed with osteoporosis;[10] ii) acute onset of back pain emerged passively and actively during the clinical examination by the physician with load-dependent character; iii) lack of clinical-radiologic signs of imbalance and neurologic deficit in clinical examination; iv) detection of clinically referrable OVCFs on plain radiographs, Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI) evaluation; v) presence of decreased body vertebrae at a maximum of 50% of the initial normal anatomical aspect of sagittal view.

The study exclusion criteria were :i) patients younger than 65 years old; ii) documented previous allergic reactions in Polymethyl methacrylate (PMMA); iii) presence of active infection, inflammation, hematologic disturbances, and coagulation disorders; iv) the presence of back pain not correlated with imaginary findings; v) presence of instability and objective neurological signs at clinical examination and imaging; vi) reduction of the width of the vertebral body by more than 50%.

Methods

Seventy-seven (77) consecutive individuals with OVCFs were recruited in this prospectively designed non-randomized study. All patients were subjected to successful VP and/or KP in 2019-2020. The diagnosis was conducted by clinical examination and appropriate imaging evaluations (plain radiographs, CT scans and MRI) preoperatively. The clinical re-evaluation was performed postoperatively at particular chronic intervals at the end of the 1st week, at 6 weeks and at 3, 6, 12 months and 2 years postoperatively. Clinical assessment was conducted using the standardized Visual Analogue Scale (VAS) in conjunction with the Short Form-36 (SF-36) Health Survey Questionnaire in order to assess HRQoL.

Surgical technique

All surgical operations were performed by the same experienced in Minimally Invasive Spine Surgery surgeon (Stylianos Kapetanakis). All procedures were performed under general anesthesia and under constant fluoroscopic guidance in anteroposterior (AP) and lateral views (two C-ARMs).

The level of operation was initially determined by fluoroscopic imaging, and the needle entry point was marked on the patients' skin located 2-4 cm lateral to the midline. Skin disinfection was subsequently conducted, and sterilization of the area was performed. An incision of less than 1cm with a lancet number 11 was conducted 2-4 cm lateral to the midline (**Figure 1**). Transpedicular advancement of first trocar with confirmation of tip in the centre of vertebral body was initially conducted. Subsequently, insertion of Kirschner-wire removal of first trocar and insertion of second trocar with limited trabecular bone reaming at the center of vertebral body were conducted. This procedure was contralaterally conducted, and, thus, a bipedicular approach in all patients was adopted (**Figure 2**). Infusion of bone cement (PMMA, 2-4 mL) was subsequently bilaterally performed under constant fluoroscopic guidance in AP and lateral views. En bloc removal of working trocars and skin suturing were finally performed. All patients were neurologically evaluated and transferred into the monitoring chamber for one hour and subsequently into the ward.

Visual analogue scale

VAS is a simple, illustrative method for evaluating various parameters, including pain. A horizontal line of 100 mm was utilized in the present study. Patients were asked to indicate their subjective perception of pain with a mark. The level of minimal clinically significant change was designated to be 9 mm. Other parameters (e.g., sex, age, etiology of pain) were not considered separately.[11-12]

SF-36 medical health survey questionnaire

Short Form-36 (SF-36) Medical Health Survey Questionnaire represents a widely used method for evaluating HRQoL after spine surgery.[13-14] This questionnaire consists of 36 items evaluating eight parameters reflecting patients' general health: physical function (PF), role physical (RP), bodily pain (BP), general health (GH), energy, fatigue, and vitality (V), social function (SF), role emotional (RE), and mental health (MH). Each patient was asked to complete the appropriate questionnaire at each regularly scheduled follow-up interval. Responses were collected and converted into percentage scales. A higher score is generally associated with enhanced HRQoL. A questionnaire was considered invalid if less than half of the entries were completed.[11]

Statistical analysis

Statistical analysis was conducted using STATISTICA 10.0 (StatSoft 1984–2010) and MATLAB 2016 (The MathWorks, Inc., 2016). Figures were created using MATLAB 2016 (The MathWorks Inc., 2016) and Adobe Illustrator CS3 (Adobe Systems, 2007). For non-parametric variables, Chi-square, Mann-Whitney's test and Kruskal–Wallis H test and Friedman Analysis of Variance

(ANOVA) were used to test for differences between two and multiple groups respectively. When paired data was compared, the Wilcoxon matched-pairs test was implemented. Spearman's correlation coefficient was applied to examine for potential correlations between the parameters. Multiple regression was used to investigate the potential effects of multiple parameters on the outcome measures. In all cases, the level of statistical significance was $p<.05$. The Bonferroni correction for multiple comparisons was used accordingly in post-hoc analyses.

Results

In total, 77 patients were included in the study. Demographic characteristics of enrolled individuals are presented in **Table 1**. All patients were subjected to VP/KP. No intraoperative complications were observed, and all patients were discharged on the same day. Furthermore, all patients successfully completed the intended 2-year follow-up.

Studying the functional improvement of patients, a statistically significant difference in the self-reported questionnaire was observed in all individual indices of SF-36. Pain intensity measured by the VAS score was also found to feature a significant reduction (**Table 2**).

Post-hoc analysis of the various follow-up time periods revealed a continuous improvement of all indices of SF-36 over the entire follow-up period. On the other hand, VAS was demonstrated to reach a plateau at 6 months featuring no further clinical improvement (**Table 3**).

In further correlation analysis, the improvement in all indices was found to be irrespective of age ($p > 0.19$) (**Table 4**). When comparing the early versus late intervention groups, the difference in the various indices between preoperative and two years of postoperative assessment was found to be statistically significant for PF ($U_{1,77} = 497.5$, $p = 0.01$), RP ($U_{1,77} = 546.5$, $p < 0.05$) and GH ($U_{1,77} = 490.5$, $p = 0.01$) of SF-36. When examining age, gender and time-lapse from fracture to treatment collectively as predictors of outcome measure, multiple regression analysis demonstrated a main effect of time for PF ($b=-0.25$), RP ($b=-0.33$) and GH ($b=-0.23$) at a level of $p<0.05$.

Discussion

Osteoporosis represents a persistent age-related disease considered responsible for fracture incidence in 50% of females and 20% of male gender during their lifetime.[15] More specifically, OVCFs represent a critical disabling factor for elderly individuals associated with restriction of mobility, degraded HRQoL and increased morbidity and mortality.[3]

Back pain is the principal complaint of patients with OVCFs and is described as severe in the vast majority of affected individuals. Other clinical manifestations of OVCFs include radicular pain (due to compression of neurovascular structures), myelopathy, and acute cauda equina syndrome as well

as the appearance of psychosocial phenomena, all of which are associated with considerable morbidity and even mortality. Early diagnosis of OVCFs is crucial to avoid mechanical complications such as post-traumatic kyphosis and alterations in body posture, in conjunction with the enhancement of physical strength, mobility and performance.[4,16]

VP and KP represent well-established procedures that can lead to further reduction of fractures and avoidance of a new OVCF.[17] The need for localizing the fractured vertebral body by performing profile (lateral) and anteroposterior (face) X-ray is prominent. The combination of two image converters (C- ARM) decreases the operation time, aids accurate needle insertion, and regulates cement application. VP was first described in 1987 by Galibert et al. and followed by Chiras et al. as the main surgical procedure for OVCFs while KP was described as an alternative method for the treatment of the OVCFs in 2002.[18-20] Since then, the two procedures have been acknowledged and studied by many surgeons. The main difference between the KP and VP surgical techniques is that the first allows fracture reduction by insertion of controlled inflatable balloon catheter resulting in better morphological reshaping of vertebral body.[4-5,17,21]

Several studies have been conducted to evaluate HRQoL changes in patients with OVCFs before and after MIVA procedures conduction. For this purpose, different questionnaires have been employed in order to measure this change, with the most common being SF-36 and VAS scores for pain improvement.[3, 22- 23]

Wang et al., in their meta-analysis of the literature, including 8 studies (845 patients) compared HRQoL changes between patients who underwent VP and KP for single-level OVCFs.[24] Results demonstrated that both procedures were safe and effective. The authors also concluded that KP is superior to VP regarding short-term pain relief, injected cement volume, improvement of short- and long-term kyphotic angle, and has a lower cement leakage rate, being albeit associated with a higher material cost and longer operation time.[24] Similar observations were made in the systematic review and meta-analysis by Zhao *et al.*, in addition to KP being associated with a lower incidence of new fractures.[25]

The EVOLVE trial (2019) was the first large multicenter prospective study evaluating HRQoL after balloon kyphoplasty in 354 patients with both osteoporotic and neoplastic VCFs. HRQoL was assessed using Numerical Rating Scale (NRS) for back pain, Oswestry Disability Index (ODI) andShort Form-36 Questionnaire Physical Component Summary (SF-36v2 PCS and EuroQol-5-Domain (EQ-5D). Results showed that KP is a safe procedure with the improvement of all primary endpoints in all times of follow-up.[3]

In another study, Nikoobakht *et al.* analyzed HRQoL and pain using the VAS for pain and SF-12 on 54 patients who had previously undergone conservative management for VCFs. A statistically

significant improvement was observed after KP ($p<0.001$), which continued to improve until the endpoint of the study at twelve months after the operation.[23]

In general, MIVA procedures are considered safe and efficient options for the treatment of VCFs. Moreover, results regarding pain after intervention with either VP or KP as measured by the VAS score plateaued after six months of follow-up in our study, while in the aforementioned investigation by Nikoobakht et al. VAS score continued to improve for twelve months.[23] This could be attributed to the fact that we only included patients with OVCFs, meaning our sample is more consistent than the aforementioned studies. As for SF-36, our results are in line with the already existing literature with the benefit of a longer follow-up time.

Major complications after VP and KP are rare, with severe complications occurring in approximately 8% of patients following KP and VP according to existing literature.[26] Some of the most common major complications described after the two procedures are cement leakage and emergence of adjacent OVCF. In our study, no major complications were observed, suggesting the safety of the two procedures.[24]

To our knowledge, this is the first prospective study in global literature for patients with OVCFs with an extensive follow-up time of two years. In this study, two of the most commonly used questionnaires for HRQoL were employed to determine the primary outcome: the pain VAS score and the SF-36 for the overall functionality and quality of life of patients. The latter was chosen in order to perform a more multifaceted evaluation of our individuals. Limitations of this study include the small sample size, the relatively limited follow-up duration, and the fact that this is not a randomized control trial. In view of these limitations, future researchers could work towards these directions.

Conclusions

VP and KP in this study were demonstrated to be safe and efficient options for interventional treatment of OVCFs in elderly patients, improving self-reported symptoms of pain as well as overall HRQoL. Nevertheless, further randomized controlled trials with greater number of enrolled individuals with more extended follow-up intervals are required in order to exclude safer conclusions about the precise utility of these techniques in interventional management of OVCFs. Furthermore, a more detailed categorization of patients based on osteoporosis and co-existing underlying comorbidities is required, so any confounders that may falsely affect the outcome of interventions on general HRQoL could be mitigated.

List of abbreviations

HRQoL, Health-Related Quality of Life

VP, Vertebroplasty

KP, Kyphoplasty

OVCFs, Osteoporotic Vertebral Compression Fractures

MIVA, Minimally Invasive Vertebral Augmentation

VAS, Visual Analogue Scale

SF-36, Short-Form 36

WHO, World Health Organization

CT, Computed Tomography

MRI, Magnetic Resonance Imaging

PMMA, Polymethyl methacrylate

AP, Anteroposterior

PF, Physical Function

RP, Role Physical

BP, Bodily Pain

GH, General Health

V, Vitality

SF, Social Function

RE, Role emotional

MH, Mental Health

ANOVA, Analysis Of Variance

NRS, Numerical Rating Scale

ODI, Oswestry Disability Index

PCS, Physical Component Summary

EQ-5D,EuroQol-5-Domain

Correspondence: Stylianos N. Kapetanakis, Orthopaedic Surgeon-Spine Surgeon, Spine Department and Deformities, Interbalkan European Medical Center, Thessaloniki, Greece.

Tel.: +306972707384 -Fax: +302541067200

ORCID id: 0000-0001-6276-2447

E-mail: stkapetanakis@yahoo.gr

Constantinos Chaniotakis
E-mail:kostas_chanio1994@hotmail.com
ORCID id: 0000-0002-8935-5566

Periklis Zavridis
E-mail:pzavridis@painclinic.com.cy
ORCID id: 0000-0002-8368-6946

Periklis Kopsidas
E-mail:periklis.kop@gmail.com

Sotirios Apostolakis
E-mail:sotapostolakis@gmail.com
ORCID id: 0000-0003-4179-2916

Nikolaos Gkantsinikoudis
E-mail:nikgkantsinikoudis@gmail.com
ORCID id: 0000-0001-7868-6880

Contributions: SK, CC, PK, SA, NG, conception and design, analysis and interpretation of data, drafting the article and critical revision of article for important intellectual content, final approval of the version to be published, agreement to be accountable for all aspects of the work; PV, analysis and interpretation of data, drafting the article and critical revision of article for important intellectual content, final approval of the version to be published, agreement to be accountable for all aspects of the work.

Conflict of interest: The authors declare no conflict of interest.

Funding: this research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics approval: The study protocol was approved by the Institutional Review Board of Interbalkan European Medical Center, Thessaloniki, Greece (Approval Code: 29.09.2018). The

study is conformed with the Helskinki Declaration of 1964, as revised in 2013, concerning human and animal rights.

Informed consent: All patients participating in this study signed a written informed consent form for participating in this study.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

References

1. Lane JM, Russell L, Khan SN. Osteoporosis. Clin OrthopRelat Res 2000;372:139-50.
2. Link TM, Majumdar S. Osteoporosis imaging. Radiol Clin North Am 2003;41:813-39.
3. Beall DP, Chambers MR, Thomas S, et al. Prospective and multicenter evaluation of outcomes for quality of life and activities of daily living for balloon kyphoplasty in the treatment of vertebral compression fractures: the EVOLVE trial. Neurosurgery 2019;84:169-78.
4. Chmielnicki M, Prokop A, Kandziora F, Pingel A. Surgical and non-surgical treatment of vertebral fractures in elderly. Z OrthopUnfall2019;157:654-67.
5. Chang M, Zhang C, Shi J, et al. Comparison between 7 osteoporotic vertebral compression fractures treatments: systematic review and network meta-analysis. World Neurosurg2021;145:462-470.e1.
6. Takahashi S, Hoshino M, Yasuda H, et al. Development of a scoring system for predicting adjacent vertebral fracture after balloon kyphoplasty. Spine J 2019;19:1194-201.
7. Hopkins TJ, Eggington S, Quinn M, Nichols-Ricker CI. Cost-effectiveness of balloon kyphoplasty and vertebroplasty versus conservative medical management in the USA. Osteoporos Int 2020;31:2461-71.
8. Hoshino M, Takahashi S, Yasuda H, et al. Balloon kyphoplasty versus conservative treatment for acute osteoporotic vertebral fractures with poor prognostic factors: propensity score matched analysis using data from two prospective multicenter studies. Spine (PhilaPa 1976) 2019;44:110-7.

9. Griffoni C, Lukassen JNM, Babbi L, et al. Percutaneous vertebroplasty and balloon kyphoplasty in the treatment of osteoporotic vertebral fractures: a prospective randomized comparison. EurSpine J 2020;29:1614-20.
10. Powell JB, Gach JE. Phototherapy in the elderly. Clin Exp Dermatol 2015;40:605-10.
11. Kapetanakis S, Gkantsinikoudis N, Charitoudis G. The role of full-endoscopic lumbar discectomy in surgical treatment of recurrent lumbar disc herniation: a health-related quality of life approach. Neurospine 2019;16:96-104.
12. Karcioglu O, Topacoglu H, Dikme O, Dikme O. A systematic review of the pain scales in adults: Which to use? Am J Emerg Med 2018;36:707-14.
13. Bombardier C. Outcome assessments in the evaluation of treatment of spinal disorders: summary and general recommendations. Spine (PhilaPa 1976) 2000;25:3100-3.
14. Zanoli G, Jönsson B, Strömqvist B. SF-36 scores in degenerative lumbar spine disorders: analysis of prospective data from 451 patients. Acta Orthop2006;77:298-306.
15. Coughlan T, Dockery F. Osteoporosis and fracture risk in older people. ClinMed (Lond) 2014;14:187-91.
16. Lenski M, Büser N, Scherer M. Concomitant and previous osteoporotic vertebral fractures. Acta Orthop 2017;88:192-7.
17. Lee MJ, Dumonski M, Cahill P, et al. Percutaneous treatment of vertebral compression fractures: a meta-analysis of complications. Spine (PhilaPa 1976) 2009;34:1228-32.
18. Galibert P, Deramond H, Rosat P, Le Gars D. Note préliminaire sur le traitement des angiomesvertébraux par vertébroplastieacryliquepercutanée [Preliminary note on the treatment of vertebral angioma by percutaneous acrylic vertebroplasty]. Neurochirurgie 1987;33:166-8. French.
19. Chiras J, Sola-Martinez MT, Weill A, Rose M, Cognard C, Martin-Duverneuil N. Vertébroplastiespercutanées [Percutaneous vertebroplasty]. RevMedInterne 1995;16:854-9. French.
20. Verlaan JJ, van Helden WH, Oner FC, et al. Balloon vertebroplasty with calcium phosphate cement augmentation for direct restoration of traumatic thoracolumbar vertebral fractures. Spine (PhilaPa 1976) 2002;27:543-8.
21. Li YY, Hsu RW, Cheng CC, Huang TJ. Minimally invasive vertebroplasty managed by a two C-arm fluoroscopic technique. MinimInvasiveTherAlliedTechnol 2007;16:350-4.
22. Lee SK, Lee SH, Yoon SP, et al. Quality of life comparison between vertebroplasty and kyphoplasty in patients with osteoporotic vertebral fractures. Asian Spine J 2014;8:799-803.
23. Nikoobakht M, Gerszten PC, Shojaei SF, Shojaei H. Percutaneous balloon kyphoplasty in the treatment of vertebral compression fractures: a single-center analysis of pain and quality of life outcomes. Br J Neurosurg 2021;35:166-9.

24. Wang H, Sribastav SS, Ye F, et al. Comparison of percutaneous vertebroplasty and balloon kyphoplasty for the treatment of single level vertebral compression fractures: a meta-analysis of the literature. PainPhysician 2015;18:209-22.
25. Zhao S, Xu CY, Zhu AR, et al. Comparison of the efficacy and safety of 3 treatments for patients with osteoporotic vertebral compression fractures: A network meta-analysis. Medicine (Baltimore) 2017;96:e7328.
26. Ma XL, Xing D, Ma JX, et al. Balloon kyphoplasty versus percutaneous vertebroplasty in treating osteoporotic vertebral compression fracture: grading the evidence through a systematic review and meta-analysis. Eur Spine J 2012;21:1844-59.

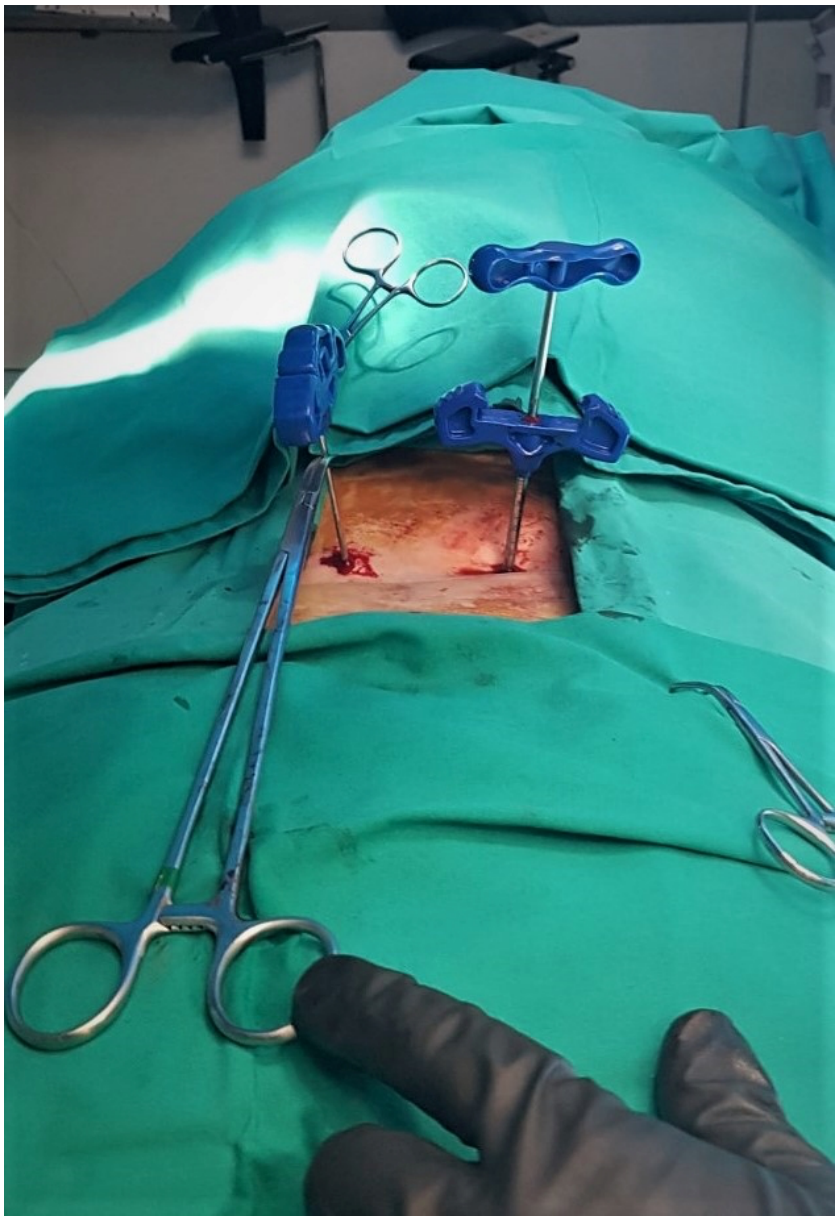


Figure 1. Two incisions of less than 1 cm (each one- bilateral), 2- 4 cm lateral to the midline. The first and the second trocars.

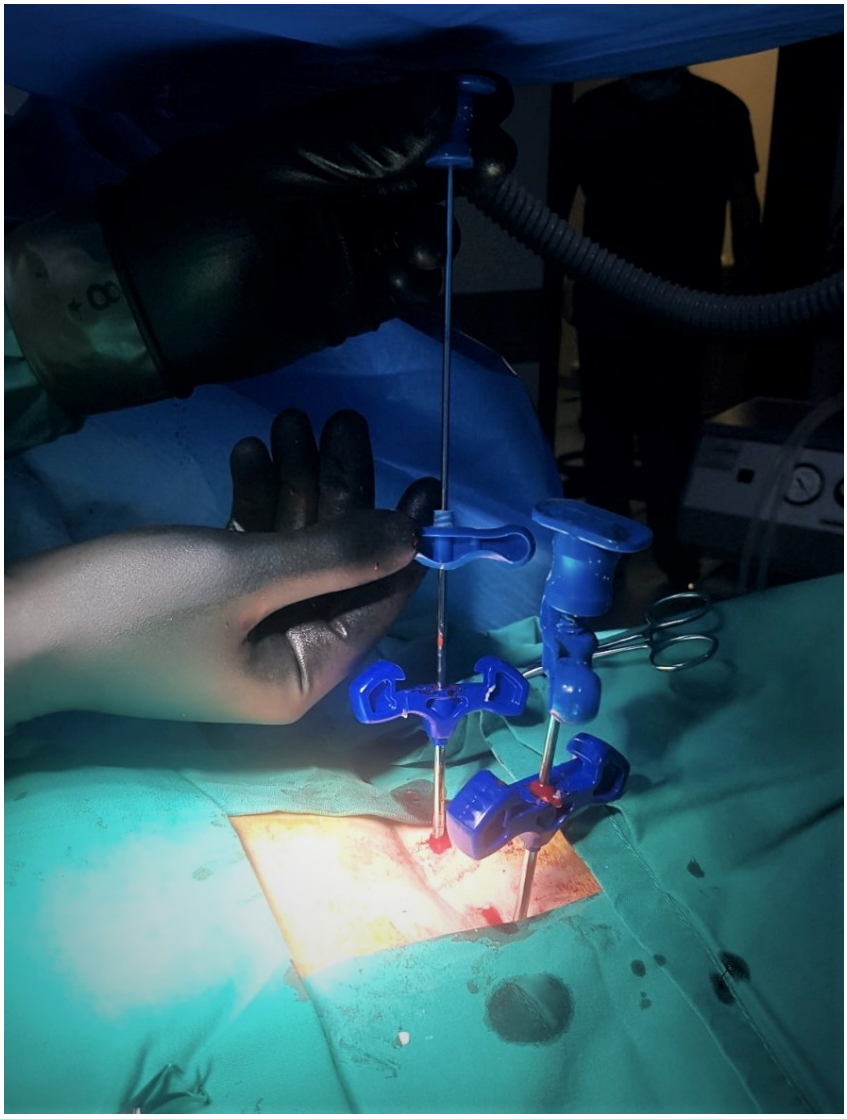


Figure 2. The bipedicular approach. Infusion of bone cement (bilaterally) was performed under C-ARM guidance.

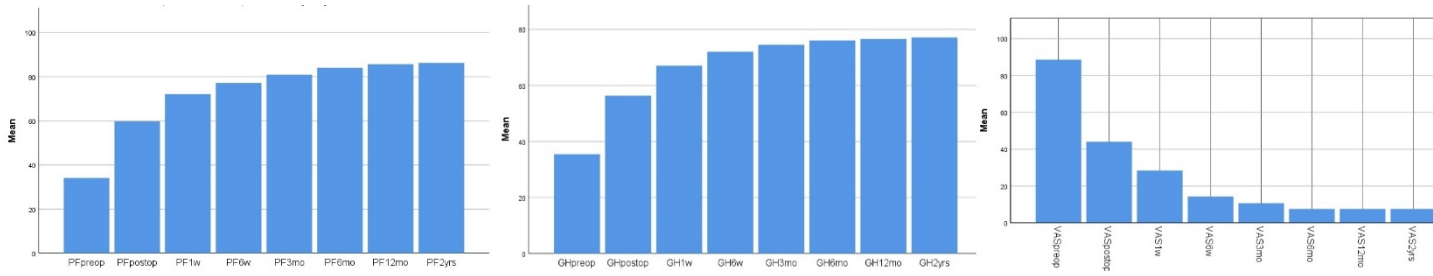


Figure 3. The changes in the value of the various parameters (PF, GH and VAS score), at each follow- up.

Table 1. Demographics of patients included in the present study.

Number of patients	77
Age Mean (SD)	75.87 (7.116)
Age Median (Min-Max)	76 (65-88)
Male (%)	23 (29.8%)
Mean Age Male (SD)	75.65 (7.374)
Mean Age Female (SD)	75.96 (7.116)

Table 2. Statistical results of overall ANOVA analysis of recorded values in studied indices

PF	F=0.99, P<0.001
RP	F=0.99, P<0.001
BP	F=0.99, P<0.001
GH	F=0.98, P<0.001
V	F=0.99, P<0.001
SF	F=0.99, P<0.001
RE	F=0.98, P<0.001
MH	F=0.99, P<0.001
VAS	F=0.94, P<0.001

Table 3. Results from Wilcoxon matched pairs test comparing each index at two successive time points of assessment. Level of significance following Bonferonni correction was $p<0.008$.

PFpreop Vs PFpostop	Z=7.62, p<0.008
PFpostop Vs PF1w	Z=7.62, p<0.008
PF1w Vs PF6w	Z=7.62, p<0.008
PF6w Vs PF3mo	Z=7.62, p<0.008
PF3mo Vs PF6mo	Z=7.62, p<0.008
PF6mo Vs PF12mo	Z=7.62, p<0.008
PF12mo Vs PF2yrs	Z=5.645, p<0.008
RPpreop Vs RPpostop	Z=7.62, p<0.008
RPpostop Vs RP1w	Z=7.62, p<0.008
RP1w Vs RP6w	Z=7.62, p<0.008
RP6w Vs RP3mo	Z=7.62, p<0.008
RP3mo Vs RP6mo	Z=7.62, p<0.008
RP6mo Vs RP12mo	Z=7.62, p<0.008
RP12mo Vs RP2yrs	Z=5.086, p<0.001
BPpreop Vs BPpostop	Z=7.62, p<0.008
BPpostop Vs BP1w	Z=7.62, p<0.008
BP1w Vs BP6w	Z=7.62, p<0.008
BP6w Vs BP3mo	Z=7.62, p<0.008
BP3mo Vs BP6mo	Z=7.62, p<0.008
BP6mo Vs BP12mo	Z=6.09, p<0.008
BP12mo Vs BP2yrs	Z=5.51, p<0.001
GHpreop Vs GHpostop	Z=7.62, p<0.008
GHpostop Vs GH1w	Z=7.62, p<0.008
GH1w Vs GH6w	Z=7.62, p<0.008
GH6w Vs GH3mo	Z=7.62, p<0.008
GH3mo Vs GH6mo	Z=7.62, p<0.008
GH6mo Vs GH12mo	Z=5.77, p<0.008
GH12mo Vs GH2yrs	Z=5.4, p<0.008
Vpreop Vs Vpostop	Z=7.62, p<0.008
Vpostop Vs V1w	Z=7.62, p<0.008

V1w Vs V6w	Z=7.62, p<0.008
V6w Vs V3mo	Z=7.62, p<0.008
V3mo Vs V6mo	Z=7.62, p<0.008
V6mo Vs V12mo	Z=6.27, p<0.008
V12mo Vs V2yrs	Z=6.09, p<0.008
SFpreop Vs SFpostop	Z=7.62, p<0.008
SFpostop Vs SF1w	Z=7.62, p<0.008
SF1w Vs SF6w	Z=7.62, p<0.008
SF6w Vs SF3mo	Z=7.62, p<0.008
SF3mo Vs SF6mo	Z=7.62, p<0.008
SF6mo Vs SF12mo	Z=6.21, p<0.008
SF12mo Vs SF2yrs	Z=5.08, p<0.008
REpreop Vs REpostop	Z=7.62, p<0.008
REpostop Vs RE1w	Z=7.62, p<0.008
RE1w Vs RE6w	Z=7.62, p<0.008
RE6w Vs RE3mo	Z=7.62, p<0.008
RE3mo Vs RE6mo	Z=7.62, p<0.008
RE6mo Vs RE12mo	Z=5.71, p<0.008
RE12mo Vs RE2yrs	Z=5.37, p<0.008
MHpreop Vs MHpostop	Z=7.62, p<0.008
MHpostop Vs MH1w	Z=7.62, p<0.008
MH1w Vs MH6w	Z=7.62, p<0.008
MH6w Vs MH3mo	Z=7.62, p<0.008
MH3mo Vs MH6mo	Z=7.62, p<0.008
MH6mo Vs MH12mo	Z=6.33, p<0.008
MH12mo Vs MH2yrs	Z=5.30, p<0.008
VASpreop Vs VASpostop	Z=7.62, p<0.008
VASpostop Vs VAS1w	Z=7.62, p<0.008
VAS1w Vs VAS6w	Z=7.62, p<0.008
VAS6w Vs VAS3mo	Z=4.62, p<0.008
VAS3mo Vs VAS6mo	Z=4.62, p<0.008
VAS6mo Vs VAS12mo	-
VAS12mo Vs VAS2yrs	-

Table 4. Spearman rank order correlation coefficients. No values were found to be statistically significant at the level of $p<0.05$.

	AGE	PF_DIF	RP_DIF	BP_DIF	GH_DIF	V_DIF	SF_DIF	RE_DIF	MH_DIF	VAS_DIF	TIME
AGE	1,000	0,018	-0,142	-0,149	0,131	0,128	0,0239	0,031	-0,014	-0,021	0,193