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Clinical Efficacy Study of Self-Setting Calcium Phosphate Artificial Bone in Assisted Treatment of Intertrochanteric Femoral Fractures

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Abstract

Objective: To investigate the clinical effect of self-setting calcium phosphate artificial bone in the assisted treatment of intertrochanteric femoral fractures. Methods: The clinical data of 46 patients with intertrochanteric femoral fractures who underwent surgical treatment in the Department of Traumatic Orthopedics of our hospital from January 2021 to June 2023 were collected. They were divided into a study group and an observation group according to whether self-setting calcium phosphate artificial bone was used during the operation. The study group comprised 22 cases, and the observation group comprised 24 cases. The observation group received only surgical treatment, while the study group received self-setting calcium phosphate artificial bone in addition to surgical treatment. The postoperative hospital stay, time to full weight-bearing (weeks), preoperative Harris hip score, and Harris hip score at the 8th week postoperatively were compared between the two groups. Results: There was no statistically significant difference in postoperative hospital stay and preoperative Harris hip score between the study group and the observation group. However, the time required for full weight-bearing postoperatively in the study group was shorter than that in the observation group ($P < 0.05$), and the Harris hip score at the 8th week postoperatively in the study group was higher than that in the observation group ($P < 0.05$). Conclusion: Self-setting calcium phosphate artificial bone-assisted hip replacement surgery can promote the recovery process of patients with intertrochanteric femoral fractures, significantly improve fracture healing, and is beneficial for the early recovery of hip joint function. It is an effective bone substitute material and can be promoted for clinical application.

Keywords

Self-Setting Calcium Phosphate Artificial Bone, Intertrochanteric Femoral Fracture, Bone Repair Material, Efficacy, Fracture Healing

1. Introduction

Intertrochanteric femoral fractures are common and quite serious orthopedic conditions among the elderly population, being one of the most severe traumas in the elderly, often referred to as the "last fracture in life" [1]. Especially among patients with osteoporosis, the incidence rate is relatively high, posing significant challenges to patients' daily quality of life and medical resources. A retrospective study on hip fractures in elderly patients in Pahang, Malaysia, showed a close correlation between the occurrence of hip fractures and increasing age, with significantly increased risks for females and specific ethnic groups (such as Chinese), among which intertrochanteric fractures accounted for up to 62.8% [2]. Considering the current trend of societal aging, the burden caused by intertrochanteric femoral fractures is expected to continue increasing, necessitating improvements in treatment strategies that promote fracture healing and reduce complications.

Traditional treatment of intertrochanteric femoral fractures mainly relies on internal fixation surgery. However, as surgery progresses, its limitations gradually become apparent. Risks of internal fixation failure, delayed bone healing, and complications such as infection and nonunion are relatively high. These issues severely affect the treatment outcome and prognosis of patients, which also prompts clinical researchers and materials scientists to seek better auxiliary treatment materials and methods. Bone cement is widely used in fracture fixation and bone defect filling due to its moldable characteristics and mechanical support function. However, traditional materials like polymethylmethacrylate (PMMA) have many shortcomings, such as bioinertness, thermal effects, and a lack of osseointegration ability, limiting their clinical application.

Self-setting calcium phosphate artificial bone, as a bioactive bone substitute material, has a chemical composition similar to human bone minerals and possesses good biocompatibility and osteoconductivity, thus becoming a research hotspot in the field of bone repair. Self-setting calcium phosphate bone cement can harden rapidly in vivo, forming a structure compatible with bone tissue, providing stable mechanical support for the fracture site, while promoting new bone formation and bone defect repair [3] [4]. Its injectable properties allow flexible use in minimally invasive surgeries. Furthermore, some new formulations have improved the material's mechanical properties and biological functions by doping different ions (such as magnesium, silver), for example, enhancing early strength and imparting antibacterial properties [5]-[7]. Additionally, adding bio-organic components like phosphoserine or chitosan can optimize the hardening kinetics and bioactivity of the bone cement, further enhancing its clinical value [8].

Given that most patients with intertrochanteric femoral fractures are elderly with osteoporosis, and the bone quality at the fracture site is poor, traditional internal fixation carries a significant risk of failure. As an auxiliary material, self-setting calcium phosphate artificial bone is expected to provide better mechanical support and a bone healing environment, reduce the rate of internal fixation failure, shorten the time required for bone healing, and decrease the incidence of postoperative complications. Related biomechanical studies indicate that calcium phosphate bone cement can enhance the stability of internal fixation devices and improve the compressive and fatigue resistance performance of the fracture site [9]. Moreover, the material's bioactivity promotes new bone formation, contributing to fracture repair and functional recovery. Therefore, systematically evaluating the clinical efficacy of self-setting calcium phosphate artificial bone in the assisted treatment of intertrochanteric femoral fractures has important theoretical significance and practical application value, providing a theoretical basis for formulating more scientific and effective clinical treatment plans.

2. Data and Methods

2.1. General Data

The clinical data of 46 patients with intertrochanteric femoral fractures who underwent surgical treatment in the Department of Traumatic Orthopedics of our hospital from January 2021 to June 2023 were collected. Inclusion criteria: (1) Age ≥ 18 years and ≤ 85 years; (2) Subjects with significant displacement or obvious gap at the fracture end of the intertrochanteric femur requiring bone defect filling; (3) No contraindications for various bone grafts; (4) Able to undergo regular follow-up (follow-up time exceeding 12 months) with good compliance; (5) Stable vital signs, no obvious surgical contraindications in physical condition; (6) Subjects informed about this experiment, patients and families have signed consent for the study; (7) Complete clinical data of the patient. Exclusion criteria: (1) Combined with other severe underlying diseases; (2) Infection at the fracture site or systemic infection; (3) Combined with mental or cognitive dysfunction; (4) Incomplete patient clinical data; (5) Unable to follow up. According to whether self-setting calcium phosphate artificial bone was used during the operation, they were divided into a study group and an observation group, with 22 cases in the study group and 24 cases in the observation group.

2.2. Methods

1) The observation group received only surgical treatment. Preoperative preparation included the following aspects: (1) Administering swelling and pain relief and symptomatic supportive treatment to alleviate patient pain and enhance the patient's physical tolerance. (2) Comprehensive evaluation of the patient's basic health status and completion of various preoperative examination items. (3) Wearing anti-rotation shoes or implementing continuous skin traction measures on the affected limb. (4) For patients with electrolyte imbalance, hypoalbu-

minemia, anemia, and abnormal coagulation function, provide drug and nutritional support therapy. (5) Hip or femoral X-ray examination, CT plain scan, and CT three-dimensional reconstruction to assess fracture type and degree. (6) Complete electrocardiogram, cardiac ultrasound, and lung CT to rule out surgical contraindications. The surgical procedures for both groups of patients were either closed reduction and InterTan internal fixation for intertrochanteric femoral fractures or closed reduction and PFNA internal fixation for intertrochanteric femoral fractures, both employing standardized surgical steps. Postoperative management: Once the patients regained clear consciousness, they were advised to consume an appropriate amount of a liquid diet and increase the intake of high dietary fiber and high-protein foods. Meanwhile, both groups received antibiotics postoperatively to prevent infection.

2) The study group received self-setting calcium phosphate artificial bone and surgical treatment. Preoperative preparation, surgical procedure, and postoperative symptomatic management were the same as those in the observation group.

2.3. Observation Indicators

(1) Postoperative recovery: Record the postoperative hospital stay and time to full weight-bearing. (2) Hip joint function: Evaluate according to the Harris hip score standard before treatment and at the 8th week of treatment. This standard covers four key indicators: pain, function, range of motion, and deformity. A higher score indicates better recovery of hip joint function in the patient.

3. Results

3.1. Comparison of Postoperative Recovery between the Two Groups

There was no statistically significant difference in postoperative hospital stay between the study group and the observation group ($P > 0.05$). The postoperative time to full weight-bearing in the study group was shorter than that in the observation group ($P < 0.05$), as shown in Table 1.

Table 1. Comparison of postoperative recovery between the two groups ($x \pm s$).

Group	n	Postoperative Hospital Stay (days)	Time to Full Weight-Bearing (weeks)
Study Group	22	9.09 ± 3.20	10.50 ± 1.54
Observation Group	24	8.75 ± 2.98	12.21 ± 1.82
t-value		0.38	3.43
p-value		0.71	0.01

3.2. Comparison of Harris Hip Scores between the Two Groups

There was no statistically significant difference in the preoperative Harris hip scores between the two groups ($P > 0.05$); at the 8th week postoperatively, the

Harris hip score of the study group was higher than that of the observation group ($P < 0.05$), as shown in Table 2.

Table 2. Comparison of Harris hip scores between the two groups (x ± s, points).

Group	n	Preoperative Harris Hip Score	Harris Hip Score at 8th Week Postoperatively
Study Group	22	54.55 ± 5.65	91.59 ± 3.23
Observation Group	24	53.17 ± 7.23	84.63 ± 4.09
t-value		0.72	6.36
p-value		0.48	<0.01

3.3. Related Complications

All 46 patients were followed up for 3 months. During the follow-up period, there were no complications such as long-term incision pain or incision infection in either the study group or the observation group. In the study group, 2 cases of postoperative complications occurred, both were deep vein thrombosis in both lower limbs. In the observation group, 5 cases of postoperative complications occurred, all of which were deep vein thrombosis in both lower limbs. A Fisher's exact test was performed to compare the complication rates between the two groups, with no statistically significant difference ($P \approx 0.43$).

4. Discussion

Self-setting calcium phosphate artificial bone is a new type of biological material with excellent biocompatibility and osteoconductive properties, gradually showing significant clinical advantages in the auxiliary treatment of intertrochanteric femoral fractures. It not only promotes the process of bone healing and shortens the patient's recovery cycle [10] but also effectively reduces the incidence of surgery-related complications [11] [12]. These findings provide new treatment ideas for clinicians, compensating for the deficiencies in bioactivity and safety of traditional repair materials.

However, the application of self-setting calcium phosphate artificial bone requires a scientific and cautious attitude. Although most existing clinical research data show positive trends, these studies are often single-center or have limited sample sizes, lacking support from large-scale, multi-center randomized observation-led studies, which to some extent limits the scope and depth of its clinical promotion. Furthermore, there are certain differences in material properties, surgical technique details, and postoperative management protocols across different studies, which also reflects that more efforts are needed in this field regarding standardized procedures and efficacy evaluation systems. As clinical workers, it is necessary to comprehensively consider the various situations found in different studies, balance the potential advantages of this material and the unresolved issues, and prevent overestimating the therapeutic effect of the material due to the

limitations of early data.

In practical operation, the standardization of surgical techniques and the optimization of postoperative management have been proven to be crucial links in ensuring the good efficacy of self-setting calcium phosphate artificial bone. Proper surgical operation can maximize the osteoconductive performance of self-setting calcium phosphate artificial bone and largely reduce the possibility of intraoperative complications. Meanwhile, individualized postoperative rehabilitation plans are equally crucial for promoting bone healing and functional recovery. Therefore, in future related research, more attention should be paid to how to effectively combine the characteristics of this material with clinical application techniques, thereby forming a relatively complete systematic treatment process to improve the overall treatment effect.

This study has several limitations. For instance, the surgical procedures were not uniform within each group, as both cohorts included patients who underwent either closed reduction and InterTan internal fixation or closed reduction and PFNA internal fixation for intertrochanteric femoral fractures, which may have influenced the observed outcomes. Additionally, this study was designed as a retrospective non-randomized comparison based on the treatments received, potentially introducing bias that may affect the generalizability and reliability of the findings.

In summary, as a bone repair material with broad application prospects, the clinical value of self-setting calcium phosphate artificial bone has initially emerged, but it still requires more high-quality, multi-center clinical research for verification. Relevant experts should actively promote interdisciplinary cooperation, integrating knowledge from materials science, surgical techniques, and clinical management experience to build a relatively complete treatment system. Only in this way can continuous innovation and widespread application of self-setting calcium phosphate artificial bone in the field of fracture treatment be truly achieved, ultimately allowing more patients to benefit from it.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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