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Original Article

Comparison of the clinical effect of DHS and PFNA on senile osteoporotic fracture and their significance of changes in BALP expression level

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Abstract

Objective: To investigate the clinical effects of dynamic hip screw (DHS) and proximal femoral nail anti-rotation (PFNA) on senile osteoporosis patients and their effects on the expression level of bone-specific alkaline phosphatase (BALP). **Methods**: 116 elderly patients with osteoporotic fracture were divided into DHS group (n=67) and PFNA group (n=49). BALP values were measured by ELISA before operation and 30 days after operation. **Results**: The operation time, the bleeding volume, and the weight-bearing time of PFNA group was shorter than DHS group (p<0.05); the dominant blood loss and occult blood loss in PFNA group were less than those in DHS group (p<0.05); the healing time and detumescence time, the complications of PFNA group was fewer than the DHS group (p<0.05). The ten-meter walking speed and the five sitting tests in PFNA group were shorter than that in DHS group (p<0.05); the excellent and good rate and Harris score in PFNA group were higher than those in DHS group (p<0.05). The expression of BALP in PFNA group was lower than that in DHS group (p<0.05). **Conclusion**: PFNA surgery has less trauma, fewer complications, more optimistic postoperative healing and recovery degree, and is more conducive to the reduction of BALP expression level.

Keywords: Bone-specific alkaline phosphatase, Dynamic hip screw, Osteoporotic fracture in the elderly, Proximal femoral nail anti-rotation

Introduction

Osteoporosis is a systemic bone disease characterized by low bone mass and degeneration of bone microstructure[1], thus, resulting in increased bone fragility with consequent susceptibility to fracture[2]. Fracture is a common complication of osteoporosis, which often occurs in the elderly over the age of 60[3]. Femoral trochanter fracture is associated with high morbidity and mortality[4], so osteoporotic fractures in the elderly has also become a significant challenge in orthopaedics.

Surgery has been known to be the best treatment option of femur or hip fractures. Dynamic hip screw (DHS) and proximal femoral nail anti-rotation (PFNA) are two commonly used surgical procedures. DHS is a traditional internal fixation technique and has advantages in treating stable fractures. The success rate of treating femoral trochanter fracture by DHS can reach 95%[5]. However, DHS also has the disadvantages of poor internal fixation stability[6], large changes in shear stress, and large surgical exposure[7], which not only seriously affects the early recovery training of patients, but also easily leads to continuous femoral varus[8]. In recent years, spiral femoral neck knives can also be applied to internal fixation systems. PFNA is a common technique for the treatment of unstable femoral intertrochanteric or intertrochanteric fractures[9]. PFNA has biomechanical advantages[10] and is the preferred method for the treatment of unstable fractures. In particular, the PFNA scheme should be given priority when facing the incomplete proximal femoral lateral cortex (such as unstable reverse tilt fracture)[4]. PFNA internal fixation arm is short, and closed reduction and internal fixation can

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Table 1. General Data of Patients in DHS and PFNA Groups [n(%)].

	DHS Group (n=67)	PFNA Group (n=49)	χ^2/t Value	P Value
Sex			0.201	0.654
Male	30(44.78)	24(48.98)		
Female	37(55.22)	25(51.02)		
Age (years)	67.24±1.66	67.47±1.44	2.877	0.437
Course of osteoporosis (year)	5.40±1.52	5.16±1.98	5.882	0.462
BMI (kg/cm^2)	20.57±1.74	20.22±1.86	0.822	0.402
BMD (g/cm^2)				
Lumbar vertebra	0.65±0.08	0.66±0.09	4.829	0.351
Femoral neck	0.57±0.10	0.54±0.09	0.194	0.288
BGP (ng/mL)	5.18±0.22	5.16±0.20	0.263	0.497
BALP (ng/mL)	20.40±1.37	20.45±1.08	3.475	0.846
Classification of fracture(AO/OTA)			0.128	0.938
A1	24(35.82)	16(32.65)		
A2	18(26.87)	14(28.57)		
A3	25(37.31)	19(38.78)		

be used through a minimally invasive incision, which can not only effectively reduce surgical tissue damage but also will not affect the blood supply to fracture site[11]. However, PFNA has higher operation costs and complicated operation[7].

Osteoporosis is a metabolic bone disorder[12]. The biochemical markers of bone metabolism in elderly patients with osteoporotic fracture are affected, so bone markers are clinically used to evaluate fracture treatment's effect[12]. Bone alkaline phosphatase (BALP) is a glycoprotein secreted by osteoblasts and participates in bone formation and mineralization[13], which can reflect the activity degree of bone cells.

At present, the best strategy for senile osteoporotic fractures is still debatable[14-16]. In this study, 116 elderly patients with osteoporotic fracture were selected as research subjects, and the various effects of DHS and PFNA on clinical efficacy and BALP expression level were compared, so as to provide reliable scientific basis for the further development of treatment of osteoporotic fracture in elderly.

Materials and methods

General information

A retrospective analysis was made on 116 elderly patients with osteoporotic fracture who were treated in the Affiliated Xuzhou Hospital of Jiangsu University from November 2015 to March 2016. The patients were divided into DHS group and PFNA group according to treatment methods. The general data was shown in Table 1. In DHS group (N=67), there were 30 male (44.78%) and 37 female patients (55.22%). The average age was 67.24±1.66 years old. The average course of osteoporosis was 5.40±1.52 years. Fracture types were classified by AO/OTA, with 24 cases of A1 type (35.82%), 18 cases of A2 type (26.87%), and 25 cases of A3 type (37.31%). In PFNA group (N=49), there were 24 male (48.98%), and 25 female patients (51.02%), with average age 67.47±1.44 years old, the average course of disease of (5.16±1.98) years, 16 cases (32.65%) of A1 type, 14 cases (28.57%) of A2 type and 19 cases (38.78%) of A3 type. There was no significant statistical difference between the two groups in gender, age, average course of disease, BMI index, BMD, bone formation index osteocalcin BGP, BALP, and other preoperative data (p>0.05).

Inclusion criteria were as follows: patients with age ≥65 years; T-value of femoral BMD was less than 2.5 standard deviations; all patients had a verified diagnosis of fresh closed fractures; patients were informed and actively cooperated with the treatment process. Exclusion criteria were as follows: patients with mental illness, contraindications, crushing of cortical bone, and necrosis of femoral bone; patients who did not cooperate with the treatment process. All patients were informed and voluntarily joined the study. This study was carried out with the consent of the Ethics Committee of Affiliated Xuzhou Hospital of Jiangsu University.

Method

Both groups of patients underwent spinal-epidural anesthesia. First, the patient, after anesthesia, was taken supine position on the traction table, and the affected limb underwent traction and reduction. With the aid of C-arm fluoroscopy, a skin incision of 5 cm was made at 2 cm from the greater trochanter of the femur, and the main needle type was determined by secondary fluoroscopy. After the DHS group main nail was inserted, the guide steel needle was inserted into the sighting device toward the femoral neck. Under C-arm fluoroscopy, the direction and depth of the guide steel needle were adjusted to ensure that it is located at the

Table 2. Comparison of Operation Related Conditions between DHS Group and PFNA Group (n).

	DHS Group(n=67)	PFNA Group(n=49)	t	*p*
Operation time(min)	106.07±4.42	84.04±4.81	1.010	0.000
Intraoperative blood loss(mL)	283.75±11.25	161.84±14.68	4.175	0.000
Postoperative blood loss (mL)	196.27±12.82	143.15±10.54	23.72	0.000
Dominant blood loss (mL)	480.02±23.17	304.99±24.74	39.05	0.000
Drainage (mL)	155.22±15.43	134.81±13.76	7.361	0.000
intraoperative blood input (mL)	214.28±14.26	127.85±13.66	32.82	0.000
Postoperative blood input (mL)	146.39±12.43	110.74±10.21	16.42	0.000
Occult blood loss (mL)	247.04±13.29	171.51±12.18	31.31	0.000
Postoperative weight-bearing time (days)	20.72±2.08	16.92±2.26	0.544	0.000
Healing time (month)	5.19±0.93	4.69±0.60	9.451	0.002
Detumescence time (week)	5.04±1.01	4.57±0.57	1.992	0.004

femoral neck, and then the lag screw was drilled. For patients with a fracture gap larger than 3 mm, the fracture gap was reduced by increasing the pressure, and then the anti-rotation nail was tightened, and the incision was sutured layer by layer. The guide sleeve was placed in PFNA group, the depth and position of the steel needle were determined through C-arm fluoroscopy, and then the locking device combined with the aiming device was used to place and lock the intramedullary nail. Finally, the nail tail cap was placed. After the surgical effect was confirmed by fluoroscopy, the drainage tube was retained, and the incision was sutured. Routine antibiotics were carried out within 1~3 days after operation to prevent infection, and patients were encouraged to take appropriate rehabilitation exercises after detumescence. Regular follow-up and reexamination were carried out after the operation. X-ray films of the hip joint were taken at the anteroposterior and lateral positions. Fracture healing was recorded according to the reexamination results to adjust the follow-up treatment plan in time.

BALP assay was performed using BALP enzyme-linked kit (Shanghai Yaji biotechnology co., ltd., product number YS00827B). The test was performed by full-time inspectors under the same standard, and the operation was strictly in accordance with the kit instructions.

Observation and evaluation indicators

1) The operation time, intraoperative blood loss, postoperative blood loss, T allogeneic blood input, drainage, total blood loss postoperative weight-bearing time, healing time, and detumescence time of the two groups were recorded. Dominant blood loss=intraoperative blood loss+Postoperative blood loss. Occult blood loss=total blood loss-Dominant blood loss+T allogeneic blood input+drainage.
2) BALP level before operation and BALP expression level 30 days after operation were recorded in the two groups.
3) The two groups' postoperative complications were recorded, including fracture, femoral partial infection, internal fixation fracture, deep vein thrombosis, femoral head necrosis, and nonunion.
4) Harris score was used to evaluate hip joint function, and Harris score results of each follow-up within 1~36 months after operation were recorded. The curative effect was divided into excellent, good, and poor. Excellent: fracture healing, no hip pain, hip movement restored to pre-injury condition, Harris score was more than or equal to 90 points; good: fracture healing, occasional hip pain, bone and joint activity mostly restored to pre-injury condition, Harris hip score was 70~89 points; poor: fracture still not healed, hip pain, unable to get out of bed, Harris hip score was less than 70 points.

Statistical analysis

Statistical analysis was performed using SPSS20.0 (Asia Analytics Formerly SPSS China) for statistical analysis. The data were expressed by mean ± standard deviation ($\bar{\chi}\pm s$). The comparison method of inter-group and intra-group data was performed with t-test. The counting data were expressed by the number of cases (n) and the percentage (%) and the comparison method in the group was χ^2 test. The 95% was taken as a confidence interval. The P-value less than 0.05 was regarded as statistical significance.

Results

Comparison of surgical indexes and postoperative complications between DHS group and PFNA group

In this study, the operation-related indexes of the two groups were statistically compared, as shown in Table 2: 1) the average operation time of DHS group was (106.07±4.42) min, that of PFNA group was (84.04±4.81) min, and the average operation time of PFNA group was significantly shorter than that of DHS group (p<0.05); 2) In DHS group, the dominant blood loss was (480.02±23.17) mL, and the occult blood loss was (247.04±13.29) mL; in PFNA group the dominant blood loss was (304.99±24.74)

Table 3. Comparison of postoperative complications between DHS group and PFNA group [n(%)].

	DHS Group (n=67)	PFNA Group (n=49)	χ^2	*p*
Intraoperative complicated fracture	1	1		
Femoral infection	2	2		
Internal fixed fracture	1	0		
Deep venous thrombosis	1	0		
Osteonecrosis of the femoral Head	1	0		
Nonunion	2	2		
Total complications	8(11.94)	5(10.20)	0.086	0.770

Table 4. Comparison of Ten-meter Walking Speed and Five Sitting Tests between Two Groups.

	DHS Group(n=67)	PFNA Group(n=49)	t	*p*
Evaluation of ten-meter walking speed (m/s)	1.06±0.12	1.13±0.12	2.116	0.002
Length of five sitting tests (s)	72.02±3.93	51.43±1.94	33.952	0.000

Table 5. Comparison of Hip Function Score between DHS Group and PFNA Group at Last Follow-up [n(%)].

	DHS Group(n=67)	PFNA Group(n=49)	χ^2	*p*
Excellent	31(46.27)	26(53.06)		
Good	23(34.33)	20(40.82)		
Poor	13(19.40)	3(6.12)		
Excellent and good rate	54(80.60)	46(93.88)	4.198	0.040
Harris score	82.70±10.24	87.45±6.27	18.461	0.005

mL, and the occult blood loss was (171.51±12.18) mL. The blood loss in PFNA group was significantly lower than that in DHS group ($p<0.05$). 3) The DHS group could bear weight after (20.72±2.08) days, the PFNA group could bear weight after (16.92±2.26) days, and the recovery of PFNA was better than that of DHS group ($p<0.05$). 4) The healing time of fracture in DHS group was (5.19±0.93) months and the detumescence time was (5.04±1.01) weeks, while the healing time in PFNA group was (4.69±0.60) months and the detumescence time was (4.57±0.57) weeks. The healing and detumescence of PFNA group were significantly better than that in DHS group ($p<0.05$).

This study analyzed and compared the postoperative complications of the two groups, as shown in Table 3. The results showed that in DHS group, there was 1 case of complicated intraoperative fracture, 2 cases of partial femoral infection, 1 case of internal fixation fracture, 1 case of deep vein thrombosis, 1 case of femoral head necrosis, 2 cases of nonunion, and the incidence rate of complications was 11.94%. In contrast, there was 1 case of intraoperative complicated fracture in PFNA group, 2 cases of femoral infection, 2 cases of nonunion, and the incidence rate of complications was 10.20%. There was no significant difference in the number of complications between the two groups ($p>0.05$), but the type of complications in PFNA group was less than that in DHS group (2 indicated 4.000, $p=0.046$).

Comparison of ten-meter walking speed and five sitting tests between DHS group and PFNA group

In this study, the ten-meter walking speed and the results of five sitting tests of the two groups of patients were counted. The data in Table 4 showed that the ten-meter walking speed in DHS group was (1.06±0.12) m/s, while the ten-meter walking speed in PFNA group was (1.13±0.12) m/s ($p<0.05$). The duration of five sitting tests in DHS group was (72.02±3.93) s, while that in PFNA group was (51.43±1.94) s, the time consumption in PFNA group was significantly less than that in DHS group ($p<0.05$).

Comparison of hip function score between DHS group and PFNA group in the last follow-up

Harris score was used to evaluate hip joint function in this study. The results of the last follow-up are depicted in

Table 6. Comparison of BALP Expression Levels before and after Operation between DHS Group and PFNA Group (ng/mL).

	DHS Group(n=67)	PFNA Group(n=49)	t	*p*
Preoperative	20.40±1.37	20.45±1.08	3.475	0.846
30 days after operation	18.05±1.42	17.33±1.20	1.650	0.005
t	26.293	29.429		
p	0.000	0.000		

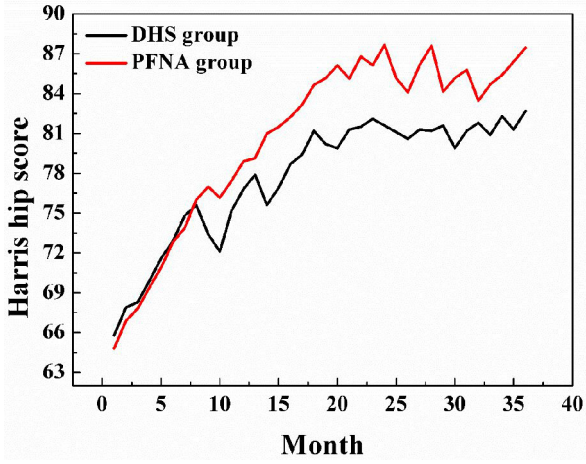

Figure 1. Graphs of Harris score changes within 1~36 months after operation.

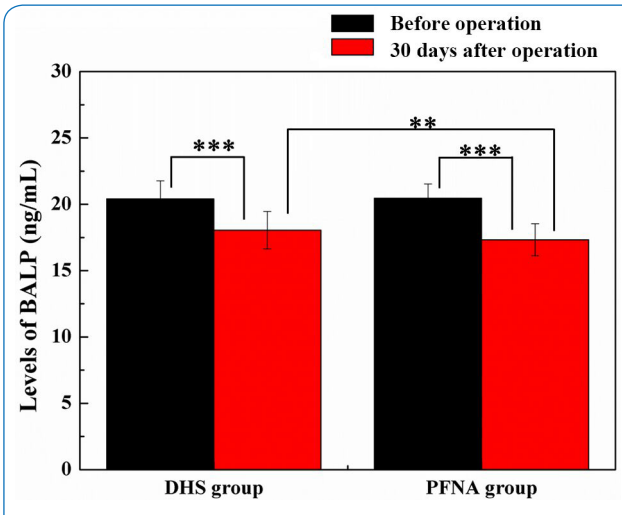

Figure 2. Comparison of BALP expression level before and after operation between DHS group and PFNA group.

Table 5. In DHS group, 31 cases were excellent, 23 cases were good, 13 cases were poor, the excellent and good rate was 80.60%, Harris score was (82.70±10.24). In PFNA group, 26 cases were excellent, 20 cases were good, 3 cases were poor, the excellent and good rate was 93.88%, Harris score was (87.45±6.27). The score of hip joint function in PFNA group was significantly higher than that in DHS group (p<0.05).

During the follow-up period, the score in DHS group increased from (65.81±5.62) to (82.70±10.24), and that in PFNA group increased from (64.83±6.34) to (87.45±6.27). Within 1~8 months after operation, the Harris scores of DHS group and PFNA group were similar, while the Harris scores of PFNA group were higher than that in DHS group later (Figure 1).

Comparison of BALP expression levels before and after operation between DHS group and PFNA group

Table 6 and Figure 2 showed the expression level of BALP before and after operation in DHS group and PFNA group. The results showed that after 30 days of operation, the BALP in DHS group decreased from 20.40±1.37 ng/mL to 18.05±1.42 ng/mL, and the BALP in PFNA group decreased from 20.45±1.08 ng/mL to 17.33±1.20 ng/mL. The difference in the expression levels of BALP before and after operation between the two groups was statistically significant. The expression level of BALP in the two groups was similar before operation (p>0.05), while that in PFNA group was significantly lower than that in DHS group (p<0.05).

Discussion

Fracture is a typical injury of osteoporosis patients[17]. According to statistics, the proportion of osteoporotic fractures among the elderly in China has increased year by year[18]. Patients with this type of fracture are often accompanied by a variety of medical diseases, so if the patient's physical conditions permit, surgery should be performed as soon as possible to avoid the increase of complications caused by long-term bed rest[19].

There are many methods in the current field, and the best scheme is still inconclusive. DHS and PFNA are two standard fixation techniques for fracture treatment. DHS is currently the standard device for the treatment of stable intertrochanteric fractures of femur[20]. PFNA combines biomechanics and minimally invasive concept of intramedullary nail[15], which can shorten the distance between hip joint and implant, thus providing a more stable biomechanical structure[21].

For elderly patients with osteoporosis, the bone metabolism system is disordered, and the levels of bone metabolism markers such as BMD, BGP, BALP are abnormal. BALP expression level is a reliable index for evaluating bone structure and performance and is also an important reference for evaluating the therapeutic effect of osteoporosis and related complications[22]. BALP exists on the cell membrane surface of osteoblasts[13,23], which can inactivate the mineralization inhibitors pyrophosphate and osteopontin[24], thus playing an important role in osteoid formation and mineralization.

The results of this study show that PFNA has shorter operation duration and less intraoperative bleeding (Table 3). There was no significant difference in the number of complications between DHS group and PFNA group, while the types of complications in PFNA group were less than those in DHS group (Table 4). The reason for the above results may be that DHS has a large incision and weak internal fixation stability, while PFNA only needs a small incision without deep soft tissue dissection and periosteal reduction at the fracture site, thus effectively reducing complications[3,14] and reducing operation risks[3]. This study compared the postoperative recovery of the two groups. The results showed that the postoperative bearing time, healing time and detumescence time of PFNA group were shorter than those of DHS group, which indicated that the postoperative recovery time of PFNA was lower. Harris score results showed that PFNA group has higher score and higher excellent rate, which indicated that PFNA group has better hip function recovery. The study also compared the data of two groups of ten-meter walking speed and five sitting tests, and the results showed that the recovery of PFNA group was better than that of DHS group. Li et al.[25] think PFNA is more conducive to promoting joint function recovery, and the results of joint function evaluation, ten-meter walking speed, and five sitting tests in this study are consistent with it. It is worth pointing out that there are statistical differences in the incidence of postoperative complications between the two groups of patients in the study of Li et al., while there is no statistical difference in the incidence in this study, which may be caused by the differences between this study and Li et al. in operation, postoperative care, and individual physique. BALP is mainly synthesized by osteoblasts and secreted into blood, an important parameter reflecting bone formation status[22]. This study compared the expression level of BALP before and after operation in the two groups. The results showed that the expression level of BALP after operation in the two groups decreased, but the expression level of BALP in PFNA group was lower than that in DHS group. In bone reconstruction, osteoclasts first begin bone resorption, then transition from bone resorption to bone formation, and finally, osteoblasts initiate bone formation[26,27]. Bone mineralization is an important link in bone formation. Alkaline phosphatase uses pyrophosphate as a substrate to generate phosphoric acid necessary for depositing minerals, thus promoting mineralization[28]. The level of alkaline phosphatase in osteoporosis patients is high[29], which may be that the balance between bone absorption and bone formation is destroyed, so the human body system secretes high-level BALP to stimulate bone formation activity and restore this balance. The above results showed that the balance of bone absorption/formation in patients might be restored to a certain extent after treatment, so the expression level of BALP decreased. The above results showed that the bone metabolism of the two groups of patients had been improved after surgical treatment, while the PFNA group has better improvement effect and the BALP expression level is lower than that of DHS group.

This study's main shortcomings were as follows: 1) The sample size was small, and there was no long-term follow-up record of big data; 2) X-ray diagnosis was used for healing, and no other methods were used for malformation diagnosis. 3) The changes of BMD, BGP, and other indexes before and after the operation in the two groups were not clarified, and more comprehensive research data were still needed.

Conclusion

Although DHS is a traditional internal fixation technique, the results of this study show that PFNA has less surgical trauma, fewer complications, more optimistic postoperative healing, and recovery degree and better curative effect than DHS. At the same time, considering the changes in BALP expression level, PFNA surgery can be considered as a better treatment strategy.

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