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Research Article

Influence of Variation in Bony Entry Point on Outcome of Intertrochanteric Femur Fractures Treated with PFNA-2

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Abstract

Intertrochanteric femoral fractures are a topic of great interest around the world. They are the most commonly operated fracture type, and the high cost of care required after injury has made them a serious health resource issue. Though it is most commonly associated with low-energy trauma in elderly patients, high-energy trauma in young patients can result in similar fracture patterns. Females have a higher risk of sustaining an intertrochanteric femur fracture than males due to greater prevalence of osteoporosis. Low-energy falls from a standing height account for roughly 90% of hip fractures in patients over the age of 50, with a higher share of the female population.

Keywords: bony entry point; low-energy trauma; elderly patients; similar fracture patterns; hip fractures; intertrochanteric femur fractures; PFNA-2; IM; EM

Introduction

Intertrochanteric femoral fractures are a topic of great interest around the world. They are the most commonly operated fracture type, and the high cost of care required after injury has made them a serious health resource issue [1]. Though it is most commonly associated with low-energy trauma in elderly patients, high-energy trauma in young patients can result in similar fracture patterns. Females have a higher risk of sustainingan intertrochanteric femur fracture than males due to greater prevalenceof osteoporosis [2]. Low-energy falls from a standing height account for roughly 90% of hip fractures in patients over the age of 50, with a higher share of the female population [3]. High-energy hip fractures are relatively infrequent and more common in men under the age of 40 [4].

Intertrochanteric and subtrochanteric femoral fractures present a challenge for the treating surgeon because the deforming forces on both the proximal and distal segments are difficult to control, especially given the proximal segment's inherent short length. The proximal segment is flexed, abducted, and externally rotated as a result of the pull of the iliopsoas, gluteus medius, and short external rotators, respectively. The unopposed pull of the adductor magnus and longus shortens and adducts the distal segment.

Aside from the difficulties in obtaining an anatomic reduction, the surgeon must ensure that the reduction is maintained throughout the process of healing. The implanted hardware is subjected to significant strain as the subtrochanteric region of the femur is subjected to mechanical forces several multiples of the patient's own weight. To accomplish this goal, various fixation options, including intramedullary (IM) and extramedullary (EM) devices, have been made available [5-7].

The strength of the fracture fragment-implant assembly is determined by several factors, namely (Kueffer et al) [8]:

a) bone quality
b) fragment geometry
c) reduction
d) implant design
e) implant placement.

Among the said factors, the surgeon can only control the quality of the reduction, the choice of implant, and its placement.

Proximal femur nail antirotaion – II, also known as PFNA-II, is a novel technology in orthopaedics. Instead of having separate derotation and compression screws, PFNA-II has a single helical blade and is suitable for patients with short stature, such as our Indian population. When the blade is driven inside the femoral head, it compacts the cancellous bone, increasing femoral head strength and stability in the cervico-cephalic direction [9].

A growing number of studies have recently shown that a poor introduction technique leads to a poor outcome [10-12]. One of the most important factor determining the success of the introduction technique is the entry point. The entry portal is crucial to determine the location of the PFNA-II after implantation and fracture reduction [13–18]. An optimal entry point serves to maintain reduction at fracture site, and also avoid implant-related complications. The objective of this study was to assess the optimal greater trochanter entry portal in patients with intertrochanteric femur fractures treated with PFNA-II implant.

Materials and Methods

The Study was conducted in the department of orthopaedics, from June 2019 to June 2021. The ethics committee clearance was given by Institutional Department of Ethics. 60 patients with intertrochanteric femur fracture, who were fitting the inclusion and exclusion criteria, were enrolled in the study after taking informed and written consent in the prescribed format.

This was a prospective comparative study done to evaluate the functional outcome of intertrochanteric femur fractures operated with Proximal femur nail antirotaion – II (PFNA II) with two different insertion points for the implant – (i) the tip of the greater trochanter and (ii) a point approximately 5mm medial to the tip of greater trochanter.

The fractures were classified pre – operatively according to the AO classification system after taking plain radiographs of :

(i) Pelvis with both hips in anteroposterior view (in 15 degrees internal rotation)

(ii) Lateral view of affected hip

Inclusion criteria:

a. All patients above 18 years of age.

b. Patients able to walk with or without aid prior to their injury.

c. Patients having stable/unstable intertrochanteric femur fracture.

Exclusion criteria:

a. Pathological fracture.

b. Patients who were not ambulatory prior to injury.

Surgical technique:

For both groups, the patient was placed on a fracture table with a perineal post after giving spinal anaesthesia. Reduction at the fracture site was achieved with traction, adduction and internal rotation.

Once the fracture had been provisionally reduced, fluoroscopy views were obtained in the sagittal and coronal planes with the help of image intensifier(C-Arm). The main difference between the protocols for the two groups was the guide pin entry point at the great trochanter. In group A, the trochanteric entry point, was through the tip of the apex of the greater trochanter in the coronal plane and at the midpoint of the antero-posterior junction of the apex of the greater trochanter in the sagittal plane. (Figure 1).

Figure 1: Bony entry from tip of greater trochanter in coronal plane

In group B, we used an entry point that was approximately 5mm medial to the trochanteric apex along the medial edge of the greater trochanter in the coronal plane and in the centre in sagittal plane (Figure 2).

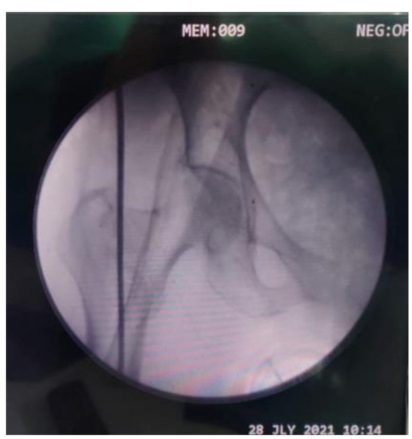

Figure 2: Bony entry 5 mm medial to tip of greater trochanter in coronal plane

A guide wire was passed distally along the femoral shaft and a crusher was used to enlarge the bony entry portal in the proximal shaft. An appropriately sized intramedullary nail was then assembled with its corresponding intramedullary angle guide attachment and inserted through the widened bony entry portal. The nail was positioned to allow proper positing of helical blade in the femoral neck and head. Next, the PFNA-II helical blade and distal screw were inserted according to the manufacturer'srecommendations. Operative time (from skin incision to skin closure) in minutes and amount of intra-operative blood loss were estimated and noted for both groups.

Radiographic assessment was done for all patients post- operatively, and the positioning of the blade in the femoral canal was evaluated as described by Cleveland Index [19].

Follow up was done at 6 weeks, and thereafter monthly upto 6 months . The functional outcome was assessed using the Harris Hip Score [20] at 6 weeks, 3 months and 6 months post-operatively. Evidence of union was analysed from radiographs of the pelvis with both hips in AP view and that of the operated hip in lateral view using RUSH score [21] at each follow up.

Date analysis: There was no bias of sex, age, mechanism of injury while choosing the samples. All data was entered the Microsoft Excel spreadsheet and variables were analysed using SPSS software. Continuous data with a normal distribution were expressed as mean ± standard deviation. Intergroup comparisons were made using the unpaired student's t-test for normally distributed variable. All hypothesis tests were two-tailed. A value of $p<0.05$ was considered statistically significant.

Observations and Results

The baseline demographic data did not vary significantly in the two groups (Table 1). There were 31 males and 29 females included in our Study (Figure 3). Age groups of patients varied from 45 years to 85 years (Figure 4). Right side was involved in 27 cases and Left side was involved in 33 patients (Figure 5). The fractures were classified according to the AO classification system pre - operatively (Figure 6) after taking plain radiographs of:

(i) Pelvis with both hips in antero-posterior view (in 15 degrees internal rotation)

(ii) Lateral view of affected hip

	GROUP A (n=30) Entry portal from tip of greate trochanter	GROUP B (n=30) Entry portal approx. 5 mm med to tip of greater trochanter	P value
Average Age (IN YEARS)	69.24 +/- 3.2	71.18 +/- 2.8	0.58
Sex Distribution	Males - 16 Females - 14	Males – 15 Females - 15	0.78 0.72
Side Distribution	Right - 12 Left - 18	Right – 15 Left - 15	0.64 0.69

Table 1: Depiction of baseline demographic data in the two groups

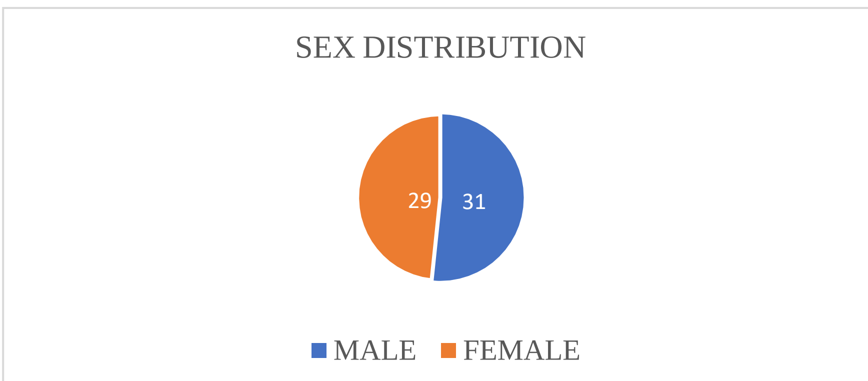

Figure 3: Sex distribution

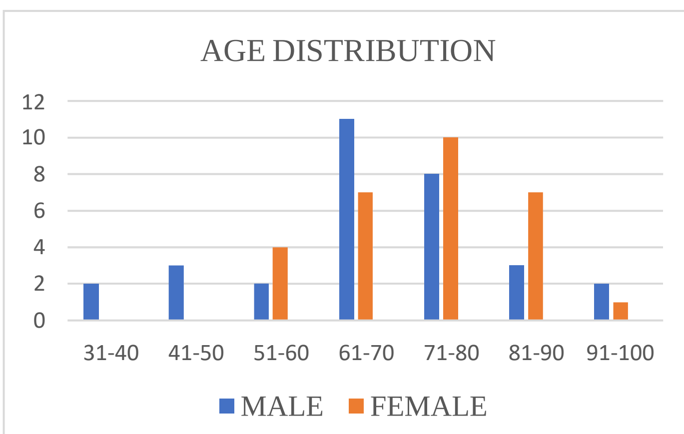

Figure 4: Age Distribution

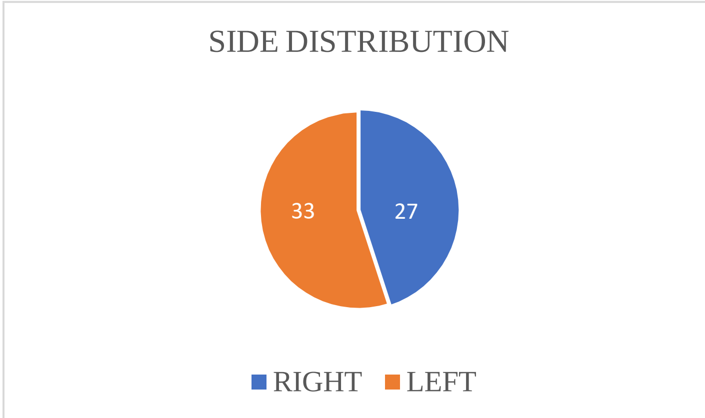

Figure 5: Side Distribution

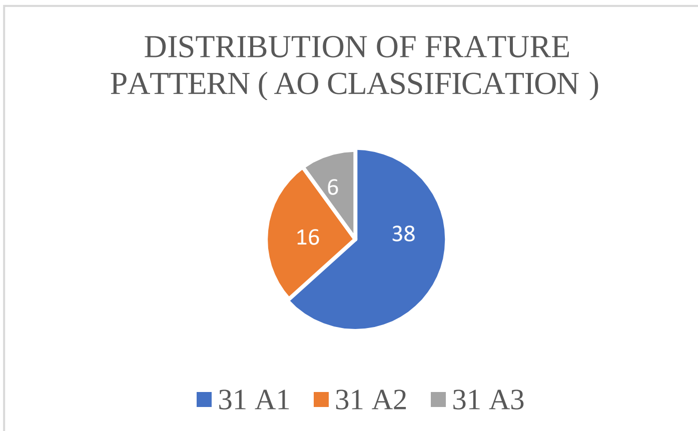

Figure 6: Distribution according to fracture pattern (AO Classification)

Two points of surgical entry were taken (Figure 7):

(i) Group A (n = 30) consisted of patients with entry portal taken at the tip of the apex of greater trochanter

(ii) Group B (n = 30) consisted of patients with entry portal approximately 5 mm medial to the tip of greater trochanter

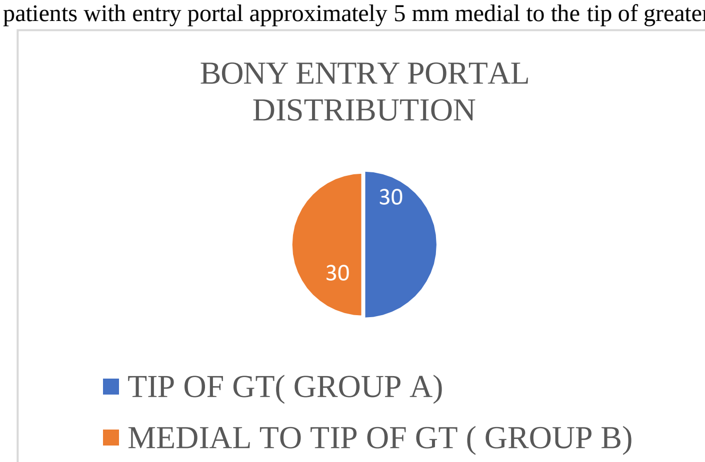

Figure 7: Distribution of bony entry portal

The present study had 38 patients with 31 A1 fracture pattern, 16 patients with 31 A2 fracture pattern and 6 patients with 31 A3 fracture pattern.

Intra-operative parameters: Average operating time (time taken from skin incision to skin closure) was significantly lower when bony entry was made approximately 5 mm medial to the tip of greater trochanter, as compared to when the entry was taken directly from the tip of the greater trochanter ($p < 0.01$). (Figure 8) Average intra-operative blood loss was significantly lower in the group where entry point was taken medial to tip of greater trochanter as compared to when the entry was taken from tip of greater trochanter ($p = 0.04$) (Figure 9)

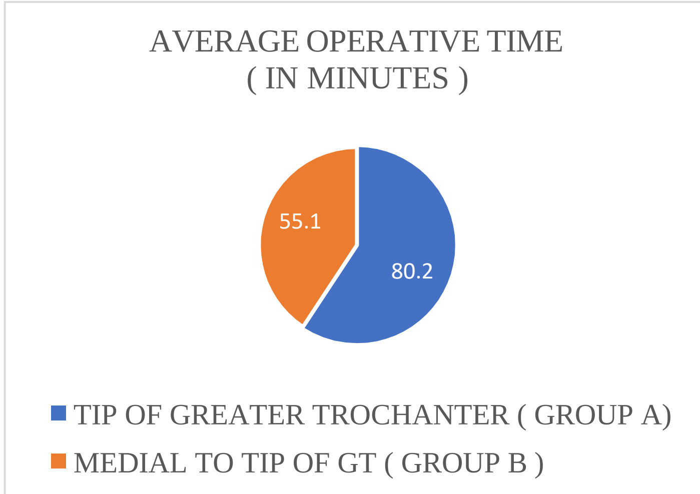

Figure 8: Average operative time in both groups (In minutes)

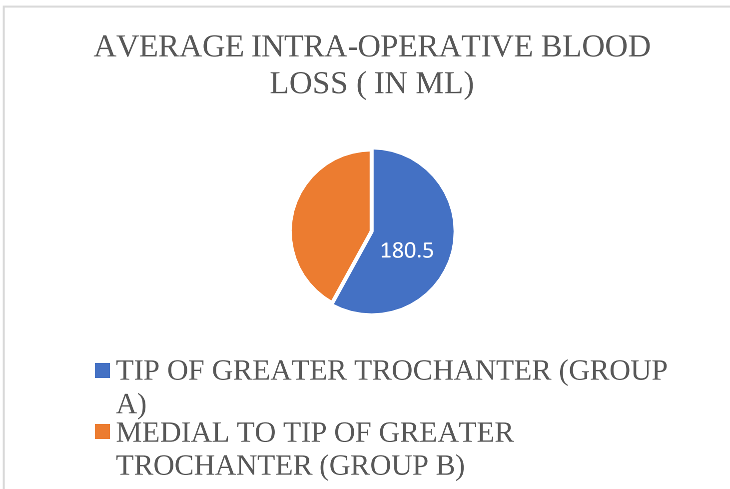

Figure 9: Average intra-operative blood loss in both groups (in ml)

Radiological parameters: According to Cleveland Index, ideal positioning of the helical blade was observed in 21 out of 30 patients in Group A and 25 out of 30 patients in Group B . Sub-optimal positioning was observed in 9 out of 30 patients in Group A and 5 out of 30 patients in Group B (p = 0.034) According to RUSH score, the average time for radiological union was 14 +/- 2.4 weeks in Group A and 14 +/- 6.8 weeks in Group B (p = 0.84)

Functional outcome: The average Harris Hip Score at 6 weeks was 72.5 +/- 8.6 in Group A and 75.54 +/- 7.3 in Group B; at 3 months was 78 +/- 6.4 in Group A and 80.45 +/- 6.1 in Group B; and at 6 months was 85.31 +/- 5.9 in Group A and 86.59 +/- 7.4 in Group B (Figure 10). There was no significant difference in the functional outcome in both groups. (p = 0.72; p = 0.68; p = 0.69)

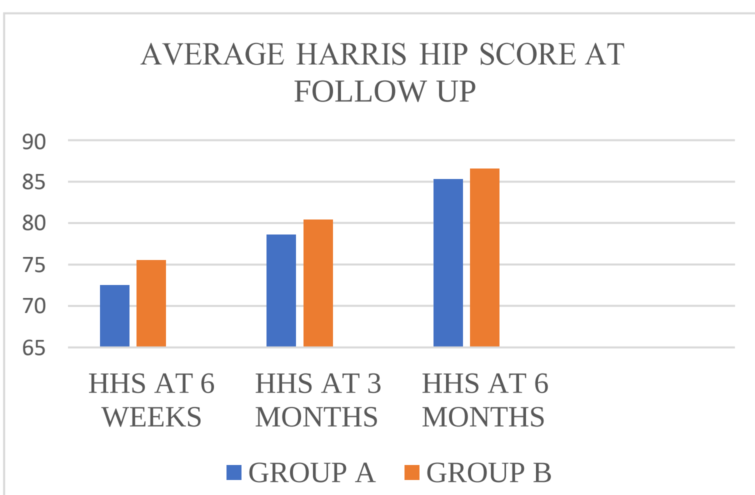

Figure 10: Average HHS at 6 weeks, 3 months and 6 months post-operatively in both groups

The results have been tabulated and depicted in Table 2.

	GROUP A (n=30) Entry portal from tip of greater trochanter	GROUP B (n=30) Entry portal approx. 5 mm medial to tip of greater trochanter	P value
Average operative time (in minutes)	80.2 +/- 5.6	55.1 +/- 6.9	<0.01
Average intra-operative blood loss (in ml)	180.5 +/- 7.5	130.58 +/- 8.2	0.04
Cleveland Index:			
Ideal positioning	21	25	0.041
Sub-optimal positioning	9	5	0.034
Average time to radiological union in weeks (according to RUSH score)	14 +/- 2.4	14 +/- 6.8	0.84
Harris Hip Score (HHS):			
At 6 weeks	72.5 +/- 8.6	75.54 +/- 7.3	0.72
At 3 months	78 +/- 6.4	80.45 +/- 6.1	0.68
At 6 months	85.31 +/- 5.9	86.59 +/- 7.4	0.69

Table 2: Results

Complications: 2 patients in Group A with suboptimal Cleveland Index reported with varus collapse and helical screw backout. Revision surgery with exchange nailing was performed for both these patients. No such cases were reported in Group B . *Figure 11 depicts varus collapse and helical blade backout at post-operative 4 months in a patient where entry was taken from tip of greater trochanter*.

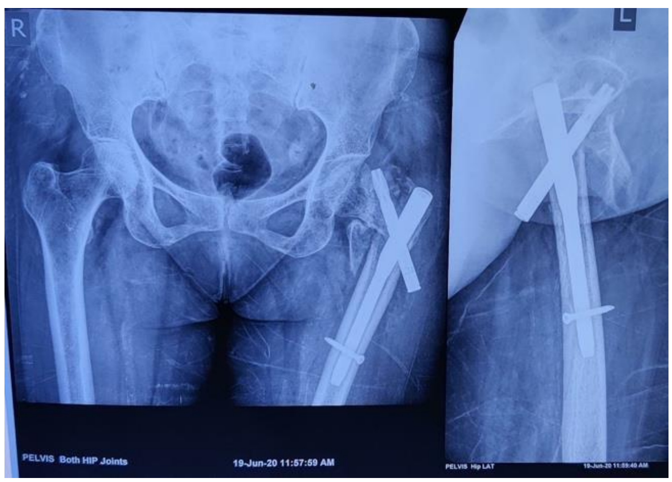

Figure 11: Varus collapse and helical blade backout at post-operative 4 months in a patient where entry was taken from tip of greater trochanter

7 out of 30 patients in Group A reported with persistent abductor lurch and 6 out of 30 patients in Group A reported persistent lateral thigh pain at the end of 6 months. 3 out of 30 patients in Group B reported a persistent abducted lurch and 2 out of 30 patients in Group B complained of persistent lateral thigh pain at the end of 6 months. (p < 0.01; p = 0.028) (Table 3)

	GROUP A (n=30) Entry portal from tip of greater trochanter	GROUP B (n=30) Entry portal approx. 5 mm medial to tip of greater trochanter	P value
Varus collapse and helical screw backout	2	0	0.036
Persistent abductor lurch	7	3	<0.01
Persistent lateral thigh pain	6	2	0.028

Table 3: Complications

Discussion

The bony entry portal is pivotal to the implant's success. It allows swift implant insertion, reducing the total operative time and intra-operativeblood loss while also ensuring good fracture reduction. It also facilitates in the maintenance of reduction during the post-operative period and allows the patient to be mobilised at the earliest [2]. The baseline demographic data was similar in both groups.

When the entry point was taken approximately 5 mm medial to the tip of the greater trochanter as opposed to the tip of the greater trochanter, the average operative time and intra-operative blood loss were significantly lower (p <0.05). These contradicted the findings of a study conducted by Pan et al.

(2017) [22]. This could be attributed to the present study's small sample size.

In a study by Kane et al. [23], the ideal position of the screw was found to be in the lower-center and center-center positions, resulting in stable fixation. According to the Cleveland index, 9 of 30 patients with entry from the tip of the greater trochanter had sub-optimal entry, while 5 of 30 patients with medial entry had sub-optimal entry. Patients with medial entry had significantly better helical blade positioning in the femoral canal ($p = 0.034$). 2 patients in Group A with sub-optimal placement of the blade showed evidence of varus collapse and helical screw backout post-operatively . There have been no reports of such cases in patients with medial entry.

The complications of persistent abductor lurch and persistent lateral thigh pain were significantly higher in patients with entry from the tip of trochanter as compared to those in whom a medial entry was used. Our findings were consistent with those of Sharan Mallya et al (2020) [24], who found a significantly higher incidence of varus collapse, lateral cortex impingement, and helical screw backout in patients who underwent a lateral entry from the tip of greater trochanter. Macheras et al. [25] concluded that a medialised entry for PFNA-2 reduced lateral cortex impingement in unstable peri-trochanteric fractures. McConnell et al. described higher damage to the gluteus medius insertion due to a lateral entry from the tip, resulting in a persistent abductor lurch post-operatively [26].

There was no significant difference between the two groups when theaverage time required for radiological union of the fracture and clinical outcomes in terms of Harris Hip Score were compared. Tao et al. [27] emphasised that regardless of implant type and characteristics, the insertingtechnique is the most important factor in achieving stable fixation without complications.

Conclusion

Both entry points gave equivocal functional outcome post-operatively and did not bear influence on the time required for radiological union at fracture site ($p > 0.05$) However the ideal positioning of the blade according to Cleveland Index could be achieved smoothly with a shorter operative time with a medial entry. The complications of helical blade backout with varus collapse, persistent abductor lurch and persistent thigh pain were higher when entry was made directly through tip of greater trochanter. Overall, to achieve a smooth operative experience with minimal intra-operative blood loss, ensure better fixation at the fracture site with optimal implant positioning and a lower incidence of post-operative complications, we recommend a bony entry made approximately 5 mm medial to the tip of greater trochanter.

Limitations of the study

Our study had the limitation of a short follow up period of 6 months, and a small sample size.

Conflicts of Interest

The authors report no conflicts of interest.

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