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Treatment of intertrochanteric fracture with the Gamma AP locking nail or by a compression hip screw – a randomised prospective trial

S.-R. Park, J.-S. Kang, H.-S. Kim, W.-H. Lee, Y.-H. Kim

Department of Orthopaedic Surgery, Medical College, Inha Hospital, Inha University, Sungnam, Korea

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Abstract. *The Gamma AP (Asia-Pacific) locking nail (GAPN) is a modification of the standard Gamma locking nail made especially for use in Oriental patients. We made a randomised prospective comparison of the compression hip screw (CHS) and the Gamma AP locking nail for the internal fixation of 60 intertrochanteric fractures of the hip in elderly patients by comparing perioperative details and analysing the radiographic and clinical results. The operation time for the GAPN group was shorter than for the CHS group and the intraoperative blood loss was lower. The Gamma AP nail enabled earlier mobilisation. We found no significant difference in the time to union and the length of sliding of the lag screw between the two groups. The decrease in the neck shaft angle in the Gamma nail group was significantly smaller than in the CHS patients. There were no significant mechanical complications, such as fracture of the femoral shaft or failure of fixation in the Gamma nail group. On the basis of our observations we conclude that the Gamma AP locking nail is more efficient than the CHS in the treatment of intertrochanteric fractures in geriatric patients.*

Résumé. *Le clou verrovillé Gamma AP (Asie Pacifique) est la modification du clou Gamma standard pour le morphotype Oriental. Nous avons compare au hasard la compression du col du fémur vissé au clou verrouillé Gamma AP pour la fixation de 60 fractures inter-trochantériennes du col de fémur, en comparant, les details périopératoires, en analysant la radiographie et les résultats cliniques chez des patients agés. La durèe d'opération pour le groupe GAPN était plus courte que pour le groupe CHS, et les pertes sanguines étaient plus faibles dans le groupe GAPN. Le clou Gamma AP favorise l'ambulation plus rapide. Nous n'avons trouvé aucune différence notable de temps de consolidation ni de glissement de la vis entre les deux groupes. La diminution d'angle cervico-diaphysaire dans le groupe clou Gamma était nettement moindre que celle du groupe CHS. Il n'y avait, pas de probléme mécanique grave dans le groupe clou Gamma comme la fracture de diaphyse femorale ou la fixation defailiante. Nous concluons que dans le traitement de la fracture intertrochanterienne de patients agés, le clou verrorillé Gamma AP serait plus efficace que le CHS.*

Introduction

The Gamma nail has mechanical advantages over the existing implants in the management of pertrochanteric fractures. The theoretical advantage of using a femoral nail instead of a side plate is that the nail is nearer to the axis of weightbearing through the femoral head and leverage is thereby reduced. There have been several reports of complications with use of the Gamma nail including fractures of the femoral shaft [2, 15, 21]. A modified Gamma Asia-Pacific locking nail has been developed following a series of anthropometric studies of Chinese femora conducted by Leung [14].

We made a randomised prospective comparison between use of the compression hip screw and the Gamma AP locking nail in the internal fixation of 60 intertrochanteric fractures of the hip by comparing perioperative details and analysing the radiographic and clinical results in elderly oriental patients.

Reprint requests to: J.-S. Kang, Department of Orthopaedic Surgery, College of Medicine, INHA University Hospital, 3309-327, Taepyung-Dong, Sujung-Gu, Sungnam-Si, Kyunggi-Do, Korea, Tel.: +82-342-720-5852; Fax: +82-342-754-7235

Materials and methods

Between January 1993 and June 1995, 60 consecutive intertrochanteric fractures of the femur seen at the Inha General Hospital, Inha University, Sungnam, Korea were prospectively randomised into two groups based on their medical record numbers. Thirty of these fractures were treated with a Gamma AP nail (the GAPN group) and the others were treated with a compression hip screw (the CHS group). All patients were over 60 years of age and were followed postoperatively for a minimum of 12 months. Preoperative parameters which were recorded included age, sex, fracture pattern, complete blood count, concurrent medical problems, the American society for anaesthesiologists (ASA) score and walking ability before the fracture. The fracture patterns were recorded as stable or unstable in accordance with the criteria of Tronzo [20].

There were no significant differences in walking ability before injury, anaesthetic risks, fracture type and stability between the two groups (Table 1). Compression hip screws (135°) were inserted using a standard technique. The Gamma AP nail was inserted using a closed technique under image intensifier control. The operative time, blood loss and time to union were recorded.

Anterior-posterior radiographs were compared to assess the neck shaft angle and the length of sliding of the lag screw in the immediate postoperative period and at the final follow up after healing. Sliding of the lag screw was measured in serial films using the method described by Doppelt [7], with minor modification for the Gamma AP nails. Mobilisation of the GAPN group of patients was started using crutches two weeks after operation. A similar regime was used for patients with a CHS except for those with unstable fractures who were allowed to bear weight after minimal callus was evident on their radiographs.

Mobility was assessed three months after operation using the method described by Ceder et al. [4]. Mobility was categorised as confined to bed, a wheelchair, with support required from another individual, use of a walking frame, rollator or a quadriped, a walking stick and requiring no support. The Student's *t*-test and chi-square test were used for analysis of variables measured on an interval scale and a nominal scale. The difference between the two groups was statistically significant when $P<0.05$.

Table 1. Preoperative data of the 60 patients with intertrochanteric fracture

	GAPN group (n=30)	CHS group (n=30)	P-value
Sex (M:F)	10:20	14:16	>0.05*
Mean age (year)	73.7	72.2	>0.05#
Pre-fracture mobility			
Independent	22 (73%)	19 (63%)	>0.05**
Aided	8 (27%)	11 (37%)	
Chair/bed bound	0	0	
Anaesthesic risk			
Grade 1	3 (10%)	4 (13%)	
Grade 2	19 (63%)	16 (53%)	>0.05**
Grade 3	8 (27%)	9 (30%)	
Grade 4	0	1 (3%)	
Fracture pattern (Tronzo)			
Stable (II)	14 (47%)	11 (37%)	>0.05*
Unstable (III & IV)	16 (53%)	19 (63%)	

* Chi-squre test
** Wilcoxon rank-sum test
# Student *t*-test

Results

The mean follow-up was for 18.5 months (12–31 months). The two groups were statistically similar in respect of their demographic and preoperative data (age, sex, prefracture ambulatory status, fracture pattern, and complete blood count). There were 20 female and 10 male patients with a mean age of 73.7 years in the GAPN group and 14 male and 16 female patients with a mean age of 72.2 years in the CHS group (Table 1). Approximately 50% of the fractures in each group were unstable. The duration of the operation, blood loss and the time to union are shown in Table 2.

Preoperative preparation time after anaesthesia was about 20 min in both groups. The duration of the operation and the amount of blood loss were significantly less in the gamma nail group (Table 2). The time to union was similar in the two groups with one non-union occurring in the CHS group (Table 2).

There was a greater decrease in the neck shaft angle of the femur in the CHS group than in the GAPN group (Table 3). The sliding length of the lag screw was slightly more in the CHS group but the difference was not significant (Table 4).

Table 2. Operative and post-operative details

	Gamma nail	CHS	P-value
Mean operation time (min)	79 min	94 min	0.03
Mean blood loss (ml)	462 ml	622 ml	0.01
Mean time to union (weeks)	14.3 wks	15.1 wks	0.06
stable	14.28 wks	14.55 wks	0.73
unstable	14.31 wks	15.42 wks	0.03

Table 3. The decrease of neck-shaft angle

Fracture type	Gamma nail	CHS	P-value
Stable fracture	2.31°	4.09°	0.01
Unstable fracture	3.81°	5.58°	0.04
Total	3.14°	5.10°	0.03

* Stable vs. unstable
in the Gamma nail group: $P>0.05$
in the CHS group: $P>0.05$

Table 4. The length of sliding of the lag screw

Fracture type	Gamma nail	CHS	P-value
Stable fracture	2.21 mm	2.36 mm	0.87
Unstable fracture	5.69 mm	6.32 mm	0.53
Total	4.38 mm	5.03 mm	0.43

* Stable vs. unstable
in the Gamma nail group: $P<0.05$
in the CHS group: $P<0.05$

Table 5. Mobility assessment (Ceder et al.)

Score	Mobility	Gamma nail	CHS
0	Confined to bed Wheelchair or require		1
1	Support by another individual	1	2
2	Walking frame	2	1
3	Rollator		1
4	Quadriped	3	4
5	Walking stick	8	7
6	Requiring no support	16	14
Mean		5.1	4.7

* Gamma nail vs. CHS: $P>0.05$

Table 6. Complications

	Gamma nail	CHS
Fracture of the shaft of the femur	0	0
Greater trochanteric fracture	1	0
Fracture displacement by nail insertion	2	0
Superior penetration of the lag screw	1	1
Progressive varus deformity	1	2
Infection	1	1
Nonunion	0	1
Loss of reduction	0	1

All the patients could walk before their injury and the mobility by three months after operation is shown in Table 5. Sixteen patients in the GAPN group and 14 in the CHS group were mobile without external support by three months. The average scores of postoperative mobility as assessed by the method of Ceder et al. [4] were 5.10 in the Gamma nail group and 4.73 in the CHS patients. A statistically significant conclusion cannot be drawn, even though the GAPN group were mobilised earlier.

The incidence of postoperative complications was similar in both groups, but the patterns were different (Table 6). Superior penetration of the lag screw, coxa vara deformity and deep infection developed in each group. The GAPN group had additional problems including fracture around the greater trochanter and loss of anatomical reduction during the insertion of the nail. These did not influence the final outcome and the fractures went on to unite.

Discussion

A sliding hip screw is commonly used for the fixation of intertrochanteric fractures as it provides secure fixation and controlled impaction [7, 8, 11, 12]. This approach gives satisfactory results in the majority of stable fractures but not in those in which the posteromedial fragment has not been reduced anatomically. There is then impaction with shortening of the neck of the femur and the leg with reduction of the leverage of the hip abductors [5, 6, 9]. The Gamma locking nail is an intramedullary device which was introduced after the success of closed intramedullary nailing of fractures of the femoral. It has several theoretical advantages such as more efficient load transfer, a shorter lever arm, controlled impaction, shorter operation time and less soft tissue dissection [1, 10, 17, 18]. The Gamma nail has been used since 1989 for fractures around the trochanter. The overall results have been satisfactory and many intraoperative complications have been due to mismatch of the standard nail to the Oriental femur [13, 14, 15, 19]. The modified Gamma Asia-Pacific Locking nail was developed following a series of anthropometric studies of Chinese femora conducted by Leung [14]. The modification included changing the medio-lateral curvature from 10° to 4°, adjusting the length of the nail to 180 mm and the proximal migration of the lag screw hole from 4.5 mm to 5.7 mm. The Gamma AP nail extends the benefits that are offered by the successful standard Gamma locking nail to the specific needs of the large population of the Asia-Pacific communities.

Following a biomechanical study of the Gamma nail, Rosenblum et al. [18] commented that nonphysiological strain was applied to the proximal femur due to its inherent stiffness and suggested that it could have an adverse effect on fracture healing. We obtained a faster union time in the GAPN group presumably because of the greater stability of fixation of the fracture [18].

The perioperative blood loss was significantly less with the gamma nail than with the compression hip screw probably because of the short operative time and the closed technique, which requires only a 5 cm incision with a small split in the abductor muscle. By contrast, the CHS technique takes longer and requires a bigger incision with elevation of the vastus lateralis.

Larsson et al. [12] reported that the neck shaft angle was decreased more in unstable fractures than in stable injuries even though there was no significant difference in the first postoperative radiographs. They concluded that it was due to medial impaction of the fracture surfaces. In our study decrease of the neck shaft angle occurred less in the GAPN group than in the CHS group and was unrelated to the fracture pattern. It may be due to the more stable structure of the Gamma nail, the biomechanical advantages of the shorter lever arm and the greater resistance to bending which will lessen the tendency to medial impaction.

Larsson et al. [12] found that detectable sliding of the lag screw occurred in more than 90% of the hips. Rosenblum et al. [18] showed that the less sliding was seen with the lag screw of the Gamma nail than with the hip screw, perhaps due to the larger diameter of this screw, which creates a greater screw nail interface. Bridle et al. [2] found that the sliding length of the lag screw was not significantly different in the two groups, and Leung et al. [15] reported that the sliding of the lag screw was less frequent in the GAPN group than in the CHS group. Our study showed that sliding in the Gamma nail group was

slightly less than the CHS group but the difference was not significant.

The majority of patients were allowed to bear weight with a crutch or walker two weeks after operation. The group with unstable fractures treated with the CHS were allowed to take weight-after minimal callus formation became apparent on the radiographs. Our patients tended to be mobilised later because of lack of co-operation or their poor general condition.

Leung et al. [3, 15] reported that the patients treated by the Gamma nail were able to achieve full weight-bearing in a significantly shorter time, although by only four days. Others who have used the Gamma nail have commented that the patients feel more secure about early weight bearing [3, 16]. The Gamma nail becomes more load bearing with increasing instability of the fracture.

The overall incidence of complications with the two implants is much the same but the pattern is different. Both may experience varus collapse, superior cutting out of the lag screw and infection. Complications specific to the Gamma nail are fractures around the greater trochanter and fracture displacement by nail insertion. Fracture around the greater trochanter occurred due to previous comminution of the lateral cortex or eccentric reaming, as the entry point was too lateral. Anatomical reduction was lost in several stable fractures due to the insertion of the nail, probably due to the stiffness and geometry of the Gamma nail. These fractures remained stable and went on to heal. In some instances the proximal tip of the nail was prominent, leading to painful bursitis and tenderness. These complications are more common with the Gamma AP nail than with the standard type because the lag screw is relatively smaller.

Fracture of the shaft of the femur may occur with use of the Gamma nail either intra- or postoperatively. Failure to overream, hammering the nail into position and using too large a nail, either alone or in combination, may cause intraoperative fracture. A fracture of the shaft after the operation is more serious because it usually requires another procedure in an elderly patient. Rosenblum et al. [18] suggested that compressive loads around the end of the Gamma nail may be a factor in producing these fractures. while Radford et al. [17] hypothesised that the shape of the nail caused pressure in the medial cortex of the subtrochanteric region and on the lateral cortex at the tip of the nail. These authors no longer use the Gamma nail because the risk of femoral shaft fracture outweighs the benefits of its use. We did not experience a fracture of this nature. We were careful to use accurate preoperative templating, a nail that was 2 mm narrower than the reamer and insertion of the nail by hand, not by hammering. We avoided use of the nail in the presence of a narrow intramedullary canal.

Non-union in the management of an intertrochanteric fracture is a rare but serious complication, which necessitates reoperation due to persistent pain and fatigue failure of the implant [12]. The patient with non union in the CHS group was successfully treated with a Gamma nail and autogenous bone graft.

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