Chi-Chuan Wu · Zhon-Liau Lee

Low success rate of non-intervention after breakage of interlocking nails

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Abstract We followed 12 patients with nailed femoral shaft fractures in which breakage of the static locked nail occurred during fracture treatment. Only two fractures united. The remaining ten fractures had to be treated with exchange nailing after a median of 10 (4–14) months. Nine fractures healed after a median of 5 (4–7) months and one was lost to follow-up. Although breakage of a proximal static reamed femoral locked nail may imitate the effect of dynamisation, the success rate is low. Early exchange nailing is a more successful option to achieve fracture union.

Résumé Nous avons suivi 12 malades présentant une fracture diaphysaire fémorale enclouée avec rupture du clou pendant la période de traitement. Seulement deux fractures ont consolidé. Les dix autres fractures ont été traitées par un changement de clou après un délai moyen de 10 mois (4–14). Neuf fractures ont consolidées dans un délai moyen de 5 mois (4–7) mois et un malade a été perdu de vue. Bien que la rupture d'un clou verrouillé puisse imiter l'effet de dynamisation, le taux de succès dans ce cas est très faible. Le changement de clou précoce est une meilleure option pour aboutir à la guérison de la fracture.

Introduction

Static reamed locked intramedullary nails are the treatment of choice for most complex femoral shaft fractures [4, 6]. Increased experience and technological advancement has gradually lowered the rate of implant failure. Despite this, locked nail breakage may still be observed unpredictably [10, 12].

Femoral locked nail breakage often occurs either at the proximal slot end or the upper distal locked screw hole [10, 12, 15]. The cause is the greater stress concentration at these two areas. When the femoral shaft fracture is still un-united, treatment of locked nail breakage usually should be revised with a new intramedullary nail [15]. However, under certain circumstances, for example, a middle- or lower-third shaft fracture with nail breakage at the proximal slot end, an effect similar to dynamisation may be induced while the stability may still be sufficient. Thus, one must question whether a revision procedure is still necessary. We, therefore, wanted to test this hypothesis to clarify whether surgical revision was necessary when nail breakage occurred.

Materials and methods

From May 1996 to July 2001, we saw 12 consecutive adult (>15 years) patients who had an un-united middle- or lower-third femoral shaft fracture with concomitant breakage of the proximal slot end of a static reamed locked nail. Patients were aged a median of 27 (19–38) years with a male-to-female ratio of 5:1. The duration from the static reamed locked nail insertion to breakage of the proximal part of the nail was a median of 7 (4–10) months. All fractures had been treated surgically one to three times, and the period from the fracture to the latest surgical procedure with a static locked nail was a median of 13 (0–20) months. Four fractures had arisen from one-stage femoral lengthening using the locked nailing technique for a median of 7 (6–8) months. No wound infection history was noted. All fractures were due to motorcycle accidents. Patients with fractures proximal to the type III subtrochanteric area were excluded [11]. In such patients, the relatively short lever arm was considered inadequate for conservative management, and exchange nailing was performed as early as possible. Ten fractures were located in the middle third of the shaft while two were in the distal third of the shaft.

The protocol of treatment of such a situation was well explained to patients. No early revision surgery was sug-

C.-C. Wu (✉) · Z.-L. Lee
Department of Orthopedics, Chang Gung Memorial Hospital,
5 Fu-Hsin St., 333, Kweishan,
Taoyuan, Taiwan
e-mail: ccwu@mail.cgu.edu.tw
Tel.: +886-3-3281200
Fax: +886-3-3278113

gested in the outpatient department (OPD). Revision surgery was suggested when the fracture was still un-united a year later or patients could not tolerate further waiting. No restriction against full weight bearing or using crutches was advised. However, it was recommended to avoid heavy labouring where possible. Patients were followed up in the OPD at intervals of 1.5–2 months. Clinical and radiographic progress was recorded. If the policy of waiting to heal failed, exchange nailing with closed removal of the broken nail was performed. After the fracture healed, patients were followed up in the OPD annually or whenever necessary.

We defined fracture union as no pain, no tenderness and patients who could walk without aid; radiographically, solid callus had bridged both fragments. Non-union was

defined as a fracture that was still un-united after 1 year of treatment or if revision surgery had to be done to achieve fracture union [11, 15].

Results

All 12 patients completed the study (Table 1). Only two patients achieved fracture union without revision surgery; the duration from nail breakage to union was 4 and 7 months, respectively. The remaining ten fractures were treated with exchange nailing at a median of 10 (4–14) months after nail breakage. Nine fractures healed at a median of 5 (4–7) months (Fig. 1). One patient was lost post-operatively despite our best efforts to make contact.

Table 1 Clinical data for 12 patients with breakage of proximal static reamed femoral locked nails

	Gender	Age (year)	Fracture level	No. of months from fracture to latest surgical treatment	Number of surgical procedures (including the latest)	Latest surgical procedure	Months from latest procedure to breakage of nail	Months from breakage of nail to union	Months from breakage of nail to exchange nailing	Months with union after exchange nailing	Follow-up (year)
1	M	30	Middle third	18	2	One-stage lengthening	6	4	–	–	6.2
2	M	27	Middle third	0	1	Open locked nailing	5	–	8	4	5.1
3	M	24	Middle third	20	3	One-stage lengthening	7	–	14	5	4.7
4	M	19	Distal third	13	2	Open locked nailing	8	–	10	5	4.6
5	F	34	Middle third	0	1	Closed locked nailing	6	–	11	6	4.7
6	M	27	Middle third	16	3	One-stage lengthening	8	7	–	–	3.5
7	F	38	Distal third	0	1	Open locked nailing	9	–	8	–	–
8	M	24	Middle third	14	2	One-stage lengthening	7	–	4	5	3
9	M	30	Middle third	13	2	Closed locked nailing	7	–	13	5	2.8
10	M	25	Middle third	0	1	Open locked nailing	10	–	12	5	2.4
11	M	28	Middle third	14	2	Open locked nailing	6	–	8	4	1.8
12	M	21	Middle third	0	1	Closed locked nailing	4	–	10	4	1.3

Fig. 1 A 27-year-old man sustained a right middle-third femoral shaft fracture and was treated with an open static locked nail. The nail broke at the proximal slot end (*arrow*) at 5 months. Conservative treatment failed, and exchange nailing with a new static locked nail was done 8 months later. The fracture healed uneventfully at 4 months.

No significant complications occurred in any of the surgical revision procedures. All patients with complete follow-up could return to the jobs they had before fractures occurred.

Discussion

Factors favouring fracture healing include minimal gap, adequate stability and sufficient nutrition [9]. Whether breakage of a proximally locked nail in middle- or distal-third femoral shaft fractures significantly hinder the stability for fracture healing has not yet been reported. On the other hand, breakage of a static locked nail should induce a dynamic effect. The fracture site should be compressed and the mechanical force encourage osteogenesis [2, 8]. These sceptical viewpoints may greatly deter active intervention by the orthopaedic surgeon.

In this series, only two out of 12 fractures united with the policy of waiting to heal. In other words, the dynamisation effect on promoting fracture healing was small under this circumstance. To avoid wasting time by waiting to achieve fracture union, early exchange nailing should be the treatment of choice [7, 16]. In the literature, mechanical force is considered to have a small effect on promoting fracture healing [13, 14]. Moreover, once the nail breaks, the stability is also insufficient and the union rate will be slower.

A locked nail has a slotted or non-slotted mode, and each has individual advantages and disadvantages [1, 5]. A slotted nail is less rigid, and technical complications during nail insertion are fewer. However, the slot end introduces stress concentration, and nail breakage easily occurs here [10, 12]. A non-slotted nail is much more rigid. Although it can avoid nail breakage, incautious insertion can result in

iatrogenic femoral neck fracture or a proximal cortical splitting fracture [3, 17]. Generally, non-slotted locked nails are not popular in femoral shaft fractures [1, 5]. Thus, breakage of the locked nail at the proximal slot end will continue to occur whilst slotted nails are used.

In conclusion, waiting for femoral shaft fractures to heal in the presence of proximal slot locked nail breakage has a low success rate. Early exchange nailing is a better choice for achieving fracture union.

References

1. Alho A, Moen O, Husby T, Ronningen H, Skjeldal S (1992) Slotted versus non-slotted locked intramedullary nailing for femoral shaft fractures. *Arch Orthop Trauma Surg* 111:91–95
2. Aro HT, Chao EYS (1993) Bone-healing patterns affected by loading, fracture fragment stability, fracture type, and fracture site compression. *Clin Orthop* 293:8–17
3. Browner BD (1986) Pitfalls, errors, and complications in the use of locking Küntscher nails. *Clin Orthop* 212:192–208
4. Brumback RJ, Toal TR Jr, Murphy-Zane MS, Novak VP, Belkoff SM (1999) Immediate weight-bearing after treatment of a comminuted fracture of the femoral shaft with a statically locked intramedullary nail. *J Bone Joint Surg Am* 81:1538–1544
5. Covey DC, Saha S, Lipka JM, Albright JA (1990) Biomechanical comparison of slotted and non-slotted interlocking nails in distal femoral shaft fractures. *Clin Orthop* 252:246–251
6. Hajek PD, Bicknell HR Jr, Bronson WE, Albright JA, Saha S (1993) The use of one compared with two distal screws in the treatment of femoral shaft fractures with interlocking intramedullary nailing: a clinical and biomechanical analysis. *J Bone Joint Surg Am* 75:519–525
7. Hak DJ, Lee SS, Goulet JA (2000) Success of exchange reamed intramedullary nailing for femoral shaft nonunion or delayed union. *J Orthop Trauma* 14:178–182

8. Hannouche D, Petite H, Sedel L (2001) Current trends in the enhancement of fracture healing. *J Bone Joint Surg Am* 83: 157–164
9. Karlstrom G, Olerud S (1974) Fractures of the tibial shaft: a critical evaluation of treatment alternatives. *Clin Ortop* 105:82–111
10. Tigani D, Moscato E, Sabetta E, Padovani G, Boriani S (1989) Breakage of the Grosse-Kempf nail: causes and remedies. *Ital J Orthop Traumatol* 15:185–190
11. Wu CC, Shih CH, Lee ZL (1991) Subtrochanteric fractures treated with interlocking nailing. *J Trauma* 31:326–333
12. Wu CC, Shih CH (1992) Biomechanical analysis of the mechanism of interlocking nail failure. *Arch Orthop Trauma Surg* 111:268–272
13. Wu CC, Shih CH (1992) A small effect of weight bearing in promoting fracture healing. *Arch Orthop Trauma Surg* 112:28–32
14. Wu CC (1997) The effect of dynamization on slowing the healing of femur shaft fractures after interlocking nailing. *J Trauma* 43:263–267
15. Wu CC, Shih CH, Chen WJ, Tai CL (1999) Treatment of ununited femoral shaft fractures associated with locked nail breakage: comparison between closed and open revision techniques. *J Orthop Trauma* 13:494–500
16. Wu CC, Chen WJ (2002) Exchange nailing for aseptic nonunion of the femoral shaft. *Int Orthop* 26:80–84
17. Yang KH, Han DY, Park HW, Kang HJ, Park JH (1998) Fractures of the ipsilateral neck of the femur in shaft nailing: the role of CT in diagnosis. *J Bone Joint Surg Br* 80:673–678