Ipsilateral Femoral Neck and Shaft Fractures Treated with Russell-Taylor Reconstruction Intramedullary Nails

Hsuan-Kai Kao, MD; Chi-Chuan Wu, MD; Po-Cheng Lee, MD; Chun-Yi Su, MD; Kuo-Feng Fan, MD; I-Chuan Tseng, MD

Background: Ipsilateral femoral neck and shaft fractures are rare injuries and the treatment is complicated and versatile. No single device has been considered absolutely superior to others.

Methods: Fifteen combined fractures in 15 patients were treated with Russell-Taylor reconstruction intramedullary nails (recon nails). Twelve surgeries were performed within 24 hours of trauma and the other 3 were delayed for 4-7 days due to associated life-threatening injuries. Postoperatively, protected weight bearing was permitted as early as possible.

Results: The median operating time was 250 minutes (range 125-430 min) and median blood loss was 300 ml (range 100-600 ml). Thirteen patients were followed-up for a median of 22 months (range 13-45 months). The union rates for neck and shaft fractures were 84.6% and 69.2% respectively. The median union times were 3.0 months for neck fractures and 8.5 months for shaft fractures.

Conclusions: Recon nails are alternative acceptable devices to treat combined fractures. However, the stability of neck fixation may be insufficient and restriction of vigorous activity is suggested to avoid fixation failure.

(Chang Gung Med J 2006;29:79-85)

Key words: ipsilateral femoral neck and shaft fractures, reconstructive intramedullary nail.

Ipsilateral femoral neck and shaft fractures are rare injuries and the reported incidence is 1-6% of all femoral fractures.[1-3] Normally, this type of injury is caused by high energy trauma and associated injuries are common.[4] Moreover, neck fractures are often non-displaced or minimally displaced and shaft factures are severely comminuted. Therefore, neck fractures are easily missed and shaft fractures bear significant healing problems.[5] In the literature, the rate of missed diagnosis for neck fractures is 19-50% and the complication rates for shaft fractures are closely correlated with various treatment methods.[3-5]

Although isolated femoral neck fractures may have high rates of head osteonecrosis and neck nonunion, combined neck and shaft fractures are reported to have a relatively better outcome.[4-6] This is attributed to the fact that the majority of energy sustained in this type of trauma is dissipated in the shaft. Therefore, the outcome after treatment of combined fractures may be mainly decided by methods of treatment for shaft fractures.[4,6] The reported incidence of head osteonecrosis in combined fractures is 3-4% and in isolated neck fractures, 10-35%.[4,6-8]

Methods of treatment of combined fractures are

From the Department of Orthopaedic Surgery, Chang Gung Memorial Hospital, Taipei.
Received: Jul. 27, 2005; Accepted: Oct. 26, 2005
Address for reprints: Dr. Hsuan-Kai Kao, Department of Orthopaedic Surgery, Chang Gung Memorial Hospital. 5, Fushing Street, Gueishan Shiang, Taoyuan, Taiwan 333, R.O.C. Tel.: 886-3-3281200 ext. 2423; Fax: 886-3-3289582; E-mail: samiyadon@adm.cgmh.org.tw

numerous.[4,8] However, no single device has been shown to be absolutely superior to others. Locked or unlocked intramedullary nails are the treatment of choice for most femoral shaft fractures. Shaft fractures are the key for treatment of ipsilateral femoral neck and shaft fractures. We deduce that reconstruction nails should play an important role in the treatment of combined fractures.[4,6,9] In the literature, the success rate of recon nails has varied from 25% to 100%.[4,6,10,11] The purpose of this retrospective study was to review our experience with this treatment and, possibly further clarify the role of recon nails.

METHODS

Between January 1999 and December 2003, 15 ipsilateral femoral neck and shaft fractures were treated with Russell-Taylor recon nails (Smith & Nephew, Warsaw, IN, USA) at our institution. There were 7 men and 8 women with a median age of 43 years (range 21-70 years). All fractures were caused by vehicle crashes.

Three patients had associated head, chest, and abdominal injuries and 8 patients had other associated fractures. Ten combined fractures were on the right side and 5 were on the left. Neck fractures included two Garden type I (13%), four type II (27%), and nine type III, (60%).[12] Shaft fractures consisted of one Winquist type I, nine type II (60%), three type III (20%), one type IV and one segmental.[13] Three shaft fractures were open (Two Gustilo type I and one type II).[14] The location of the shaft fractures were the middle-third in 12 (80%), the distal-third in 2 (13%) and segmental in 1.

Twelve patients were treated with recon nails within 24 hours. The other 3 patients had associated life-threatening conditions and treatment was delayed for 4-7 days until their critical conditions ameliorated.

Surgical technique

All patients were anesthetized with endotracheal intubation and placed on the fracture table in the supine position. Both lower limbs underwent traction on the foot plates. Initial closed reduction was not attempted. An image intensifier was routinely used in the operation. The involved limb was kept in an adducted position to facilitate the closed nailing procedure.

A guide wire was inserted through the piriformis fossa into the marrow cavity of the proximal fragment and reaming was done. Consequently, an L-shaped manipulation rod was inserted into the marrow cavity and the fragment ends of the shaft fractures were reduced in a closed fashion. After the guide wire was passed into the marrow cavity of the distal fragment, reaming was repeated.

A recon nail which was 1-mm smaller than the guide wire was inserted along the guide wire into the distal femur. Then, the lower limb was abducted 15 degrees. The neck-shaft angle was checked with the image intensifier. The recon nail was rotated to adjust for an adequate inlet to insert two proximal locked screws, which had to be positioned inferiorly in the anteroposterior view and centrally in the lateral view. Sometimes, the neck required manipulation and temporary stabilization with a 3 mm Kirschner wire (Mizuho, Tokyo, Japan) to assist locked screw insertion. Two proximal and two distal locked screws were inserted to reinforce the stability.

After the operation, patients were allowed to ambulate with partial weight bearing as early as possible. Patients were followed-up in the outpatient department at 4-6 week intervals to assess the clinical and radiographical fracture healing processes.

We defined fracture clinical union as no pain, no tenderness, and no need for aids to assist ambulation. Radiographical union was defined as bridged trabecullae across the fracture site or solid callus with cortical density connecting both fragments. Nonunion was defined as a fracture site which remained unhealed one year after treatment or a which required a second surgery to achieve union.[5,9]

For the convenience of comparison, Fisher's exact test was performed to compare the union rate of the femoral neck and shaft. A *p*-value less than 0.05 was considered significantly different statistically.

RESULTS

Thirteen patients were followed-up for a minimum of one year (range, 13-45 months; median, 22 months). Two patients were lost to follow up despite our best efforts to contact them (Table 1).

The median operating time in the 15 patients was 250 (range 125-430) minutes and the median blood loss was 300 (range 100-600) ml.

Table 1. Clinical Data of 15 Patients with Ipsilateral Femoral Neck and Shaft Fractures

Case no.	Age/ gender	Type of garden	Type of winquist	Type of open wound	Location of shaft fracture	Union time of neck fracture (months)	Union time of shaft fracture (months)	Treatment of complications	Follow-up (months)
1	25/M	3	2	C	A	2.5	7	O	45
2	42/M	3	3	C	B	1.5	8	O	37
3	38/F	1	3	C	A	3.0	10	O	30
4	55/F	3	2	C	A	3.0	6	O	28
5	70/M	2	S	C	A + B	3.0	N	P	26
6	41/F	1	3	1	A	L	L	L	L
7	25/M	3	2	2	A	6.0	11	O	23
8	62/F	3	4	C	A	N	N	H + P	22
9	43/F	3	2	C	A	7.0	11	O	20
10	44/F	3	2	C	A	N	8	D	18
11	38/M	2	2	C	A	L	L	L	L
12	51/M	2	1	C	A	3.5	N	E	17
13	21/F	3	2	C	A	3.0	8.5	O	15
14	61/F	3	2	C	B	4.0	N	W	14
15	57/M	2	2	1	A	2.0	8.5	O	13

Abbreviations: A: middle-third; B: distal-third; C: closed; D: dynamic hip screw; E: exchange nailing; F: female; H: hemiarthroplasty; L: lost to follow-up; M: male; N: nonunion; O: none; P: plate; S: segmental; W: observation only.

One patient (case 10) sustained isolated neck nonunion and three patients (cases 5,12,14), isolated shaft nonunions. In addition, one patient (case 8) sustained neck and shaft nonunions. Thus, the union rate of the neck fractures was 84.6% (11/13) and shaft fractures, 69.2% (9/13, $p = 0.24$).

The median union times were 3.0 months (range 1.5-7.0 months) for neck fractures and 8.5 months (range 6-11 months) for shaft fractures (case 7, Fig. 1).

Except for the patients with nonunion, there was no malunion of neck fractures (neck-shaft angle < 105 degrees, > 145 degrees; anteversion < 2 degree, > 22 degrees) or shaft fractures (angulation > 10 degrees, rotational deformity > 10 degrees, shortening > 2 cm).[8,9,15]

The isolated neck nonunion (case 10) was complicated with cutout of the proximal locked screw at 5 months. It was converted to a dynamic hip screw (Synthes, Bettalach, Switzerland) and healed uneventfully. One isolated shaft nonunion (case 5) was associated with breakage of one distal locked screw at 7 months. It was treated by angled blade plating (Synthes, Bettalach, Switzerland) with cancellous bone grafting and healed uneventfully. The second isolated shaft nonunion (case 12) was treated with exchange nailing (a first- generation Russell-Taylor locked nail) and healed uneventfully. The third isolated shaft nonunion (case 14) was not treated and was observed during follow-up in the OPD.

Fig. 1 Case 7. A 25-year-old man sustained right ipsilateral femoral neck and shaft fractures due to a motorcycle accident. The combined fractures were treated with a reconstruction nail and healed uneventfully.

Treatment of the patient with combined nonunions (case 8) was complex. This patient also sustained severe chest and abdominal injuries and an emergency laparotomy was performed. Temporary external fixation was used at that time and treatment with recon nails was delayed for 7 days. The neck

fracture was initially reduced in a varus position and proximal locked screw cutout occurred at 3 months. Moreover the distal locked screws were initially missed to insert for the comminuted shaft fracture. This caused shortening of the lower extremity by 3 cm.

The neck nonunion was treated with bipolar hemiarthroplasty (Wright, Arlington, TN, USA) and the shaft nonunion with dynamic compression plating (Synthes, Bettalach, Switzerland) and cancellous bone grafting (Fig. 2).

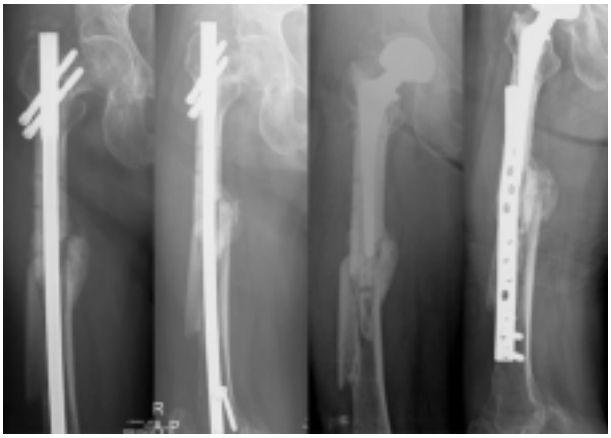

Fig. 2 Case 8. A 62-year-old woman sustained right ipsilateral femoral neck and neck fractures due to a car accident. The combined fractures were treated with a reconstruction nail but both neck and shaft nonunions occurred. The neck and shaft nonunions were treated by bipolar hemiarthroplasty and dynamic compression plating respectively.

DISCUSSION

The mechanism of ipsilateral femoral neck and shaft fractures has been enthusiastically investigated. Patients normally sustain high energy impaction with hip abduction.[4] The majority of energy is dissipated in the femur, which induces a comminuted fracture.[8,9] When the sustained energy is even higher, neck fracture occurs. However, in these situations the neck fracture is usually less severe. In the literature, most neck fractures were non-displaced or minimally displaced, which can easily be missed.[9] In contrast, in this study, Garden type III neck fractures occurred in 60% of the cases, which might have been due to higher energy during the injury.[16]

In the literature, the neck fractures in combined fractures were considered less severe and it was felt that delayed stabilization would not worsen the outcome.[8,9] Therefore, surgeons could have more time to treat life-threatening injuries. However, in this study, 60% of neck fractures were displaced (Garden type III). Because of fear of head osteonecrosis, 80% (12/15) of patients had surgery within 24 hours of trauma and the other 3 patients (20%), who could not have surgery immediately, were still treated as soon as possible. Clinical examination and radiographs were reviewed in this study and no head osteonecrosis occurred after a median of nearly two years of follow-up. No further studies such as bone scan, tomography, computed tomography or magnetic resonance imaging were used to assess the viability of the femoral head.

There are multiple treatment options for combined fractures and none are considered absolutely superior to others.[4,8] Basically, each device has individual advantages and disadvantages. A high complication rate has been reported with plating treatment of comminuted shaft fractures.[17,18] In this study, 93.3% (14/15) of shaft fractures had moderate to severe comminution, for which plating treatment is not suitable. Therefore, intramedullary nails supplemented with augmentation devices to stabilize the neck fractures were chosen. In this study, recon nails were used but shaft nonunions still occurred in 31% (4/13) of cases. The reason may be that the soft tissues and vascularity were seriously damaged, hindering the fracture healing process.[19] Clinically, as the patients discontinued the use of crutches, implant failure could have occurred.[20,21] In this study, 50% (2/4) of shaft nonunions were associated with breakage of both distal locked screws and the fixation stability was lost.

The advantages of recon nails include using one incision to treat the combined fractures and saving bony stock for the insertion of proximal screws for neck fractures.[5,10] If the reduction is performed in a closed manner, the infection rate and blood loss can be reduced. High success rates have been reported with devices with similar functions.[1,8,22-24] A first-generation locked intramedullary nail may be used on the contralateral side (i.e. a right lesion treated with a left mode nail) for the insertion of proximal locked screws into the femoral neck. Because no target devices have yet been designed, the technique is always difficult. The technique for long gamma nails

is similar to that of recon nails and outcomes may be comparative. However, to the best of our knowledge no clinical outcomes have been reported.

Before the invention of recon nails, first-generation locked intramedullary nails supplemented with multiple lag screws were commonly used to treat combined fractures. A high union rate with a low complication rate was reported.[5,11] The main difference is that with the latter, preservation of sufficient bony stock is needed for insertion of the multiple lag screws. Theoretically, the surgical technique is more complex. However, it has the advantages of stabilization in three-dimensions, which should be more stable than the two-dimension stabilization provided by recon nails.[25-27] In this study, two proximal locked screws cutout and neck nonunions occurred. Therefore, theoretically the stability provided by recon nails for neck fractures may not always be sufficient and restriction of vigorous activity before neck fractures are healed is imperative.[11] In this study, the median union time of neck fractures was 3 months.

The time interval for treating neck fractures in combined fractures is still controversial. Theoretically, neck fractures should be stabilized with lag screws as soon as possible, usually on an emergency basis.[8] Practically, this may not always be possible when other life-threatening injuries are present. In this study, three patients had treatment delayed for 4-7 days but head osteonecrosis did not occur after a nearly 2-year follow-up. This was comparative to previous reports.[9,24] The majority of energy is dissipated in the femur, which deteriorates the femoral outcomes. On the contrary, neck fractures have a better outcome and delayed treatment, if inevitable, may still result in acceptable outcomes.[9] In this study, the neck fractures healed significantly faster than the shaft fractures.

In this study, 60% (9/15) of the neck fractures were Garden type III. Two of these neck fractures resulted in nonunion due to proximal locked screw cutout. No osteonecrosis occurred in the other 7 neck fractures. This may be quite different from isolated neck fractures.[8] Deducibly, displaced neck fractures in combined fractures are not always equal to soft tissue compromise around the femoral neck. Therefore, displaced femoral neck fractures falls in the elderly may be successfully treated by multiple pinning.[8,28] The success rate may even be higher than in young patients'.[29,30]

In this study, the median operating time was 250 minutes, which was longer than with other reported intramedullary techniques.[9,22] Therefore, it is technically demanding. However, more practice may shorten the operating time and the fixation may be done more satisfactorily.

Methods for treatment of nonunions are numerous. Besides surgical intervention, biophysical enhancement including ultrasound stimulation, electrical stimulation and high-energy extracorporeal shock waves have been shown to promote bone healing. Because of the potential complications of surgery, these noninvasive methods are considered safe and effective. But they can not correct deformity or shortening and their use is restricted to fractures with little or no deformity, gap, or shortening.[31-33]

In conclusion, Russell-Taylor recon nails are alternative acceptable devices to treat ipsilateral femoral neck and shaft fractures. The union rate and the complication rate are comparative to other intramedullary devices. Basically, each technique has individual advantages and disadvantages, and all are technically demanding. When combined fractures are treated with recon nails, restriction of vigorous activity is suggested to avoid fixation failure.

REFERENCES

1. Swiontkowski MF, Hansen ST Jr, Kellam J. Ipsilateral fractures of the femoral neck and shaft: a treatment protocol. J Bone Joint Surg [Am] 1984;66:260-8.
2. Wu CC, Shih CH, Chen JY. Adult femoral shaft fracture treated with an intramedullary nail. Chang Gung Med J 1989;12:141-7.
3. Yang KH, Han DY, Park HW, Kang HJ, Park JH. Fractures of the ipsilateral neck of the femur in shaft nailing: the role of CT in diagnosis. J Bone Joint Surg [Br] 1998;80:673-8.
4. Alho A. Concurrent ipsilateral fractures of the hip and femoral shaft. A meta-analysis of 659 cases. Acta Orthop Scand 1996;67:19-28.
5. Wu CC, Shih CH. Ipsilateral femoral neck and shaft fractures: retrospective study of 33 cases. Acta Orthop Scand 1991;62:346-51.
6. Jain P, Maini L, Mishra P, Upadhyay A, Agarwal A. Cephalomedullary interlocked nail for ipsilateral hip and femoral shaft fractures. Injury 2004;35:1031-8.
7. Shih CH, Wang KC. Femoral neck fractures. 121 cases treated by Knowles pinning. Clin Orthop 1991;271:195-200.
8. Kyle RF. Fractures of the proximal part of the femur. J

Bone Joint Surg [Am] 1994;76:924-50.
9. Wu CC. Treatment of femoral shaft aseptic nonunion associated with plating failure: emphasis on the situation of screw breakage. J Trauma 2001;51:710-3.
10. Hossam EM, Adel MH, Emad EY. Ipsilateral fracture of the femoral neck and shaft, treatment by reconstruction interlocking nail. Arch Orthop Trauma Surg 2001;121:71-4.
11. Watson JT, Moed BR. Ipsilateral femoral neck and shaft fractures: complications and their treatment. Clin Orthop 2002;399:78-86.
12. Garden RS. Reduction and fixation of subcapital fractures of the femur. Orthop Clin North Am 1974;5:683-712.
13. Winquist RA, Hansen ST, Clawson DK. Closed intramedullary nailing of femoral fractures- a report of five hundred and twenty cases. J Bone Joint Surg [Am] 1984;66:529-39.
14. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty five open fractures of long bones. J Bone Joint Surg [Am] 1976;58:453-8.
15. Nordin M, Frankel VH. Biomechanics of the hip. In: Nordin M, Frankel VH, eds. Basic Biomechanics of the Musculoskeletal System. 2nd ed. Philadelphia: Lea & Febiger Co., 1989:135-51.
16. Kempf I, Grosse A, Beck G. Closed locked intramedullary nailing: its application to comminuted fractures of the femur. J Bone Joint Surg [Am] 1985;67:709-20.
17. Roberts JB. Management of fractures and fracture complications of the femoral shaft using the ASIF compression plate. J Trauma 1977;17:20-8.
18. Riemer BL, Butterfield SL, Burke CJ III, Mathews D. Immediate fixation of highly comminuted femoral diaphyseal fractures in blunt polytrauma patients. Orthopedics 1992;15:907-16.
19. Karlstrom G, Olerud S. Fractures of the tibial shaft- a critical evaluation of treatment alternatives. Clin Orthop 1974;105:82-111.
20. Wu CC, Shih CH. Biomechanical analysis of the mechanism of interlocking nail failure. Arch Orthop Trauma Surg 1992;111:268-72.
21. Wu CC, Lee ZL. Treatment of femoral shaft aseptic nonunion associated with broken distal locked screws and shortening. J Trauma 2005;58:837-40.
22. Ashby ME, Aderson JC. Treatment of fractures of the hip and ipsilateral femur with the Zickel device. A report of three cases. Clin Orthop 1977:127:156-60.
23. Harryman DT II, Kurth LA, Davis CM. Ipsilateral femoral neck and shaft fractures: report of two cases using an alternate technique. Clin Orthop 1986;213:183-8.
24. Swiontkowski MF. Ipsilateral femoral shaft and hip fractures. Orthop Clin North Am 1987;18:73-84.
25. Rehnberg L, Olerud C. The stability of femoral neck fractures and its influence on healing. J Bone Joint Surg [Br] 1989;71:173-7.
26. Husby T, Alho A, Nordsletten L, Bugge W. Early loss of fixation of femoral neck fractures: comparison of three devices in 244 cases. Acta Orthop Scand 1989;60:69-72.
27. Holmes CA, Edwards WT, Myers ER, Lewallen DG, White AA III, Hayes WC. Biomechanics of pin and screw fixation of femoral neck fractures. J Orthop Trauma 1993;7:242-7.
28. Skinner PW, Powles D. Compression screw fixation for displaced subcapital fracture of the femur: success or failure. J Bone Joint Surg [Br] 1986;68:78-82.
29. Nordkild P, Sonne-Holm S. Necrosis of the femoral head following fracture of the femoral neck. Injury 1986;17:345-8.
30. Dedrick DK, Mackenzie JR, Burney RE. Complications of femoral neck fracture in young adults. J Trauma 1986;26:932-7.
31. Rubin C. Bolander M. Ryaby JP. Hadjiargyrou M. The use of low-intensity ultrasound to accelerate the healing of fractures. J Bone Joint Surg [Am] 2001;83:259-70.
32. Wang CJ. Chen HS. Chen CE. Yang KD. Treatment of nonunions of long bone fractures with shock waves. Clin Orthop 2001;387:95-101.
33. Rodriguez-Merchan EC. Forriol F. Nonunion: general principles and experimental data. Clin Orthop 2004;419:4-12.

以拉塞－泰勒氏重建型骨髓內鋼釘治療同側股骨頸及幹的骨折

高軒楷 吳基銓 李柏成 蘇君毅 范國豐 曾益全

背 景： 同側股骨頸及幹的骨折並不常見，而治療方法不但煩雜又很有爭議。迄今仍未有單一的器材，被公認絕對會比其他器材優越。拉塞－泰勒氏重建型骨髓內鋼釘，乍看起來似乎也是一種理想的治療方法；但是臨床上報告的成功率卻差異很大 (25-100 %)，令人十分困惑。因此，我們報告自己對此治療的經驗及心得，以作爲未來的選擇。

方 法： 15 位患者遭受同側股骨頸及幹的骨折，接受拉塞－泰勒氏重建型骨髓內鋼釘的治療。12 位患者在 24 小時內被治療；但是另外 3 位患者，因同時合併有可能致命的傷害，手術被延後 4-7 天。術後，在限制負重情況下，允許患者及早下床活動。

結 果： 15 位患者的手術時間，用了 125-430（正中值，250）分鐘；而流血量有 100-600（正中值，300）毫升。13 位患者接受 13-45（正中值，22）個月的複查。股骨頸的癒合率爲 84.6 %，而股骨幹的癒合率爲 69.2 %。股骨頸的癒合時間正中值爲 3.0 (1.5-7) 個月，股骨幹則爲 8.5 (6-11) 個月。

結 論： 基本上，不一樣的器材有其較適合治療的不同型態的骨折。拉塞－泰勒氏重建型骨髓內鋼釘，是另外可選用治療同側股骨頸及幹骨折的手術方法。但由於其固定股骨頸骨折的穩定性不足，術後應限制患者過度的活動（約 3 個月），以防止固定失敗。(長庚醫誌 2006;29:79-85)

關鍵字： 同側股骨頸及幹的骨折，拉塞－泰勒氏重建型骨髓內鋼釘。

長庚紀念醫院 台北院區 骨科部 外傷骨科
受文日期：民國94年7月27日；接受刊載：民國94年10月26日
索取抽印本處：高軒楷醫師，長庚紀念醫院 骨科部。桃園縣333龜山鄉復興街5號。Tel.: (03)3281200轉2423; Fax: (03)3289582; E-mail: samiyadon@adm.cgmh.org.tw