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Two-hole side-plate DHS in the treatment of intertrochanteric fracture: Results and complications

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Summary We reviewed 83 intertrochanteric fractures fixed with a 135 degree dynamic hip screw (DHS) and two-hole side-plate. The mean age was 72 years. There were 13 A1.1, 24 A1.2, 16 A2.1, 29 A2.2 and 1 A2.3 fractures. Established osteoporosis was seen in 55 patients. The mean time to union was 14.5 weeks. Sixty-eight percent had minimal collapse, 24% moderate and 8% severe. Over 80% of moderate and severe collapses were associated with osteoporosis and an unstable fracture pattern. There were four failures: two from lag screw cut-out and two from pull-out of the side-plate.

Introduction

Intertrochanteric fracture, one of the most common osteoporotic fractures in the elderly, occurs in approximately 185.2/100,000 of the northern Thai population.[27] Surgical repair is now considered as the standard care. The exception to this rule is when the patient's medical comorbidity precludes surgery. Ideally, surgery is recommended within 2 days after the injury.[40] The aim is to provide a stable construct, which allows early mobilisation and some weight bearing to minimise the sequelae of long term recumbency. It may also restore the patient's previous level of independence and function.

External fixation is reported to be an easy and safe method for high-risk geriatric patients.[6,19,22] Primary bipolar hemiarthroplasty in an unstable intertrochanteric fracture provides a good result, due to earlier walking while bearing full weight.[18,29] A variety of internal fixation methods including fixed angle and intramedullary devices, and hip screws are available.

The dynamic hip screw (DHS), initially introduced by Clawson in 1964, remains the implant of choice because of its favourable results and low rate of nonunion or hardware failure.[8,28] Complications have been predominantly associated with cut-out of the lag screw through the femoral head.[9,11,24,31,39] Most mechanical failures involve progressive varus deformity at the fracture site. This may increase tension

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on the side-plate screws, leading to failure of the screw-bone interface.[33] However, fatigue failure of the sliding screw and pull-out or breakage of the side-plate are rarely reported.[25] Most of the clinical and biomechanical studies have studied the optimal placement of the sliding screw and the appropriate angle of insertion[10,11,13,15,37] and the DHS side-plate fixation has received little attention. From the

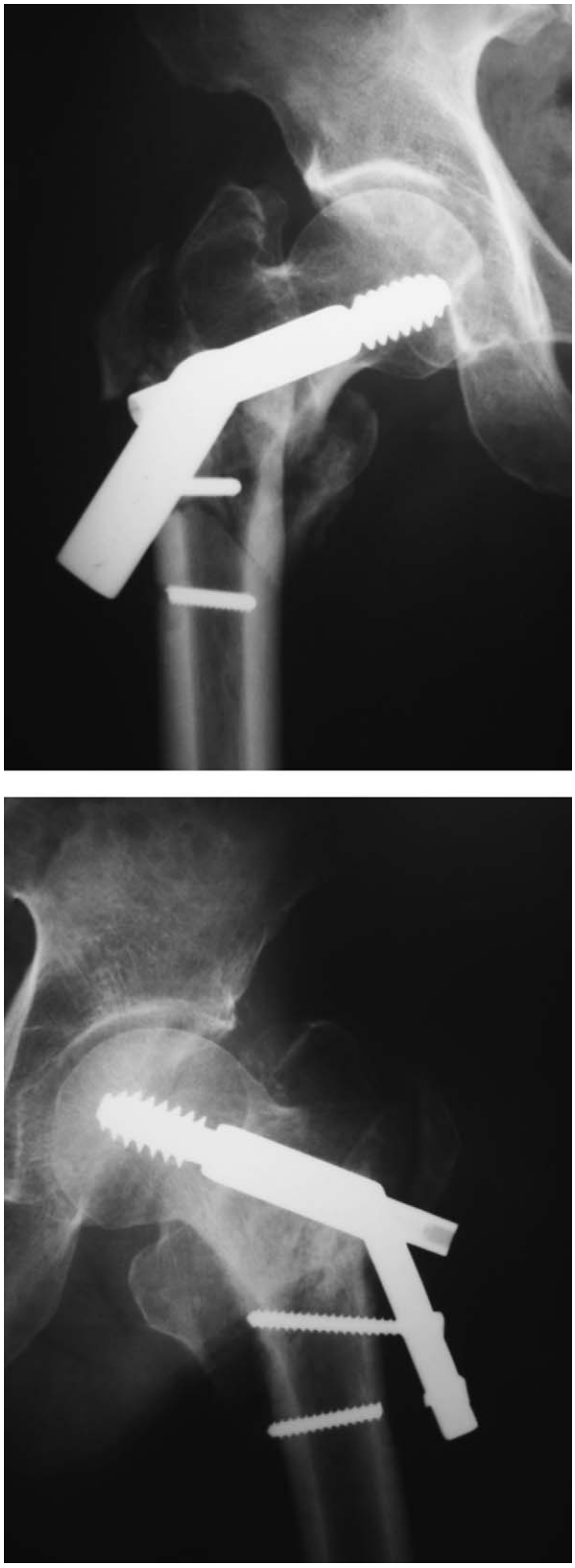

Figure 1 Two cases of side-plate failure.

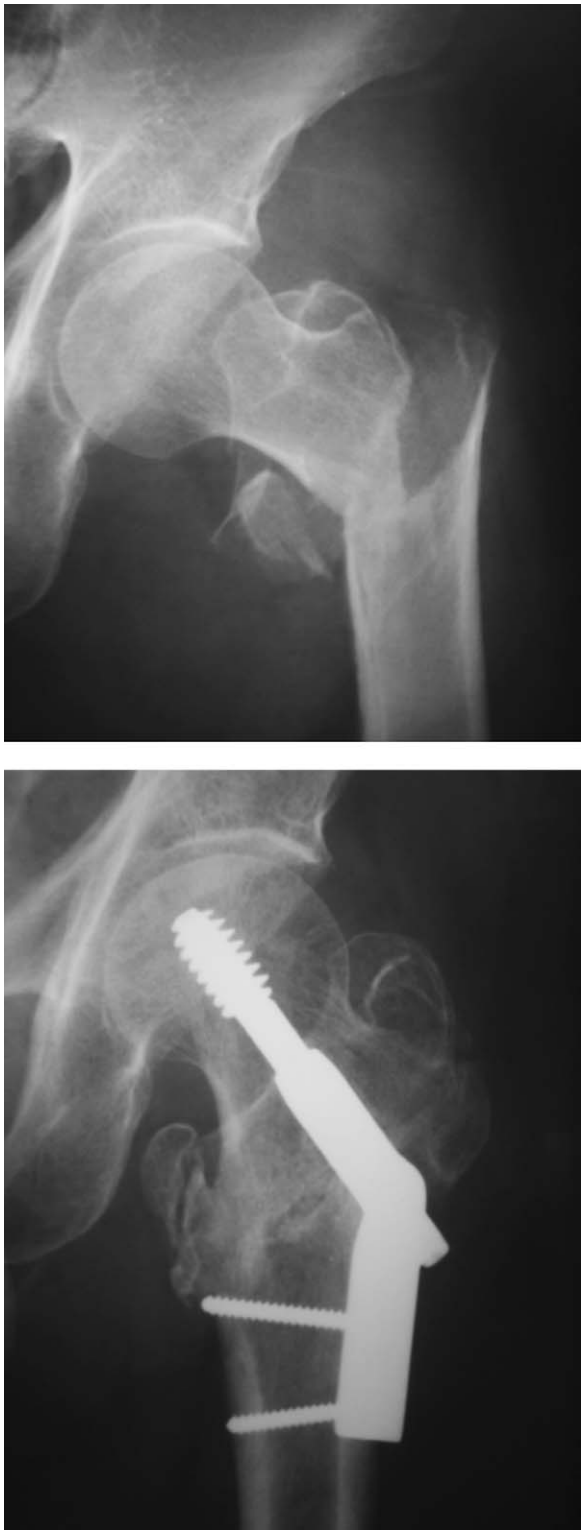

Figure 2 Pre- and post-operative radiograph of unstable intertrochanteric fracture.

biomechanical study of Yian et al., three bone screws provide adequate side-plate fixation, and additional screws are of no advantage.[38] McLoughlin et al. found no difference in the biomechanical stability of two- and four-hole DHS and supported the clinical use of the two-hole side-plate for intertrochanteric fractures.[25] Bolhofner et al. reported no failure in the two-hole side-plate DHS fixation in 69 patients.[4] DiPaola et al. reported good results with no implant failure in 13 stable intertrochanteric fractures fixed with a two-hole side-plate with the minimal incision technique.[12]

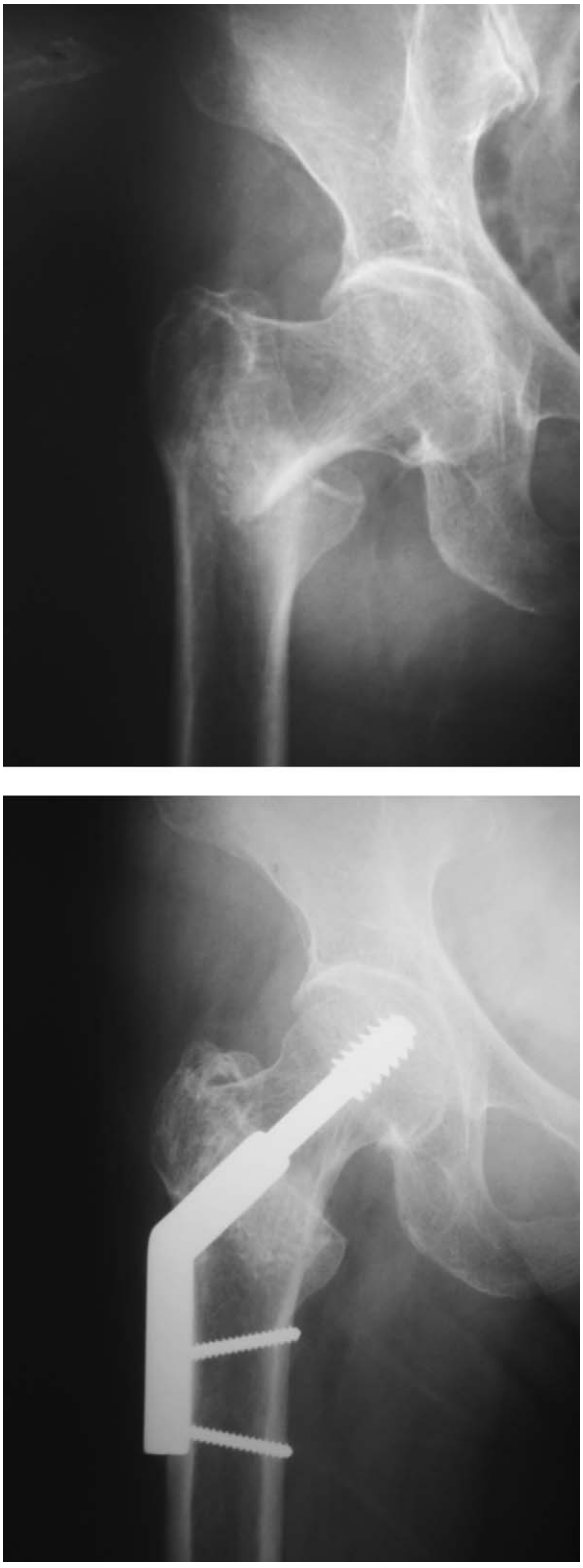

Figure 3 Pre- and post-operative radiograph of stable intertrochanteric fracture.

Owing to the small amount of clinical data on the two-hole short side-plate, the purpose of this study was to demonstrate the results and complications of using this abbreviated fixation in intertrochanteric fractures (Figs. 1—3).

Materials and methods

One hundred and twelve intertrochanteric fractures were stabilised with a 135° DHS and two-hole side-plate between January 2000 and December 2003. One patient, who died 1 month after surgery from underlying lung cancer, and five patients who were not walking preoperatively were excluded. Only 83 patients were available for regular 4—6 week follow up visits until the fracture was shown to be healed. A fracture was considered healed by the presence of painless walking and absence of fracture tenderness.

There were 30 male and 53 female patients. The mean age was 72 years. The fractures were classified by OTA classification[26] as follows: 13 A1.1, 24 A1.2, 16 A2.1, 29 A2.2 and 1 A2.3. The degree of osteoporosis (Singh's index)[32] of the contralateral hip in each case was recorded. The surgery was performed by the standard technique of DHS insertion. Perioperative antibiotic was routinely administered. No prophylaxis for deep vein thrombosis was prescribed. All patients were encouraged to walk as soon as possible after removal of the drain, usually on the second day after the operation. The patients were assessed at 4—6 week intervals for both clinical and radiological union of the fracture. At the final radiographic follow up, the degree of collapse was measured using Bendo's method.[3]

Results

The mean time to union was 14.5 weeks (6—21). Collapse was minimal in 54 cases (68%), moderate in 19 (24%) and severe in 6 (8%). The relationships between the fracture type and Singh index, fracture type and degree of collapse, and degree of collapse and Singh's index are shown in Tables 1—3, respectively.

Table 1 The relationship between fracture type and degree of osteoporosis

Fracture type	Singh's index						
	6	5	4	3	2	1	
A1.1	0	1	2	5	5	0	13
A1.2	4	1	7	7	2	3	24
A2.1	0	1	2	8	5	0	16
A2.2	0	0	10	11	8	0	29
A2.3	0	0	0	0	1	0	1
	4	3	21	31	21	3	83

Table 2 The relationship between fracture type and degree of collapse

Fracture type	Degree of collapse			
	Minimal	Moderate	Severe	
A1.1	13	0	0	13
A1.2	21	2	0	23
A2.1	13	0	3	16
A2.2	7	16	3	26
A2.3	0	1	0	1
	54	19	6	79[a]

[a] Four cases failed.

Table 3 The relationship between degree of collapse and osteoporosis

Degree of collapse	Singh's index						
	6	5	4	3	2	1	
Minimal	4	3	17	21	8	1	54
Moderate	0	0	3	8	8	0	19
Severe	0	0	1	0	3	2	6
	4	3	21	29	19	3	79[a]

[a] Four cases failed.

Complications included two screws which cut-out from the femoral head (one A1.2 fracture, Singh index 3, and one A2.2 fracture Singh index 2) and failure of the side-plate in two A2.2 fractures, Singh index 2 and 3 (Fig. 1). The first screw cut-out was treated with a total hip replacement, due to a damaged acetabulum. The second was treated by conversion to a condylar blade plate and cement augmentation. Failure of the side-plate was seen at 7 and 13 weeks after surgery. A longer side-plate was used as a replacement and the bone healed uneventfully 16 weeks later. There were no deep infections or deep vein thromboses. All other fractures healed uneventfully.

Discussion

Successful treatment of intertrochanteric fractures depends on many factors: the age of the patient, the patient's general health, the time from fracture to treatment, concurrent medical treatment, the adequacy of treatment and stability of fixation.[30] Koval et al. show that patients under 85 years old, independent in their activities of daily living prior to fracture, walking independently at discharge and with three or less medical comorbidities, are more likely to regain their prefracture independent living status.[23] Although good results of surgical treatment by various internal fixation devices have been reported, the DHS remains the implant of choice for most surgeons.[2,4,14,16,17]

The DHS allows impaction at the fracture site, shorter operating time, no need for osteotomy, good bone healing and low rate of complication. In the earliest clinical report of the DHS, a two-hole side-plate was used, and it is not clear why the four-hole side plate became the standard of fixation.[4] Yian's biomechanical study showed that three cortical bone screws allowed a favourable distribution of tensile force and adequate side-plate fixation. However, Yian et al. realised that the study was tested in a non-physiological loading position of the femoral shaft and the lag screw was prevented from telescoping. If telescoping had been allowed to occur, all cortical screw tension values would have been lower, with the two screws possibly adequate for side-plate stability.[38] McLoughlin et al. found an equivalent breaking strength between the two- and four-hole side-plate DHS in reconstruction of the three-part unstable intertrochanteric fracture, and less fracture movement was detected in a specimen fixed with the two-hole side-plate DHS.[25] Clinical studies for the two-hole side-plate were published in 1999 by Bolhofner et al.[4] and in 2004 by DiPaola et al.[12] They demonstrated good clinical outcomes, shorter operating time, less blood loss and fewer blood transfusion without

Table 4 Comparison of healing time and complications

	Bolhofner	Clawson	DiPaola	Rao	This study
Healing time (weeks)	15 (8–17)	–	13 (7–24)	18 (16–20)	14.5 (6–12)
Mechanical or technical failure (%)	4.29	18.46	None	4.03	4.82
Pneumonia, DVT or infection (%)	8.57	29.89	None	10.48	None

Table 5 Comparison of fracture collapse

Degree of collapse	Bendo	Bolhofner	This study
Minimal (%)	15	79	68
Moderate (%)	15	17	24
Severe (%)	70	3	8

failure of the fixation. In our study, the fracture healing time, rate of complication and degree of collapse were comparable with the literature as shown in Tables 4 and 5.[3,4,8,12,28] More than 80% of moderate and severe collapse were associated with established osteoporosis and an unstable fracture pattern.

Complication rates have been reported in up to 38% of cases.[36] The common causes of fixation failure are instability of the fracture, osteoporosis, lack of anatomic reduction, failure of the fixation device and incorrect placement of the lag screw in the femoral head.[10,21] Steinberg et al. found an increasing rate of failure in cases with excessive lag screw sliding of more than 15 mm.[34] Wolfgang et al. reported pull-out of the three- and four-hole side-plate DHS in two ununited intertrochanteric fractures. The lag screw failed to telescope and the barrel of the side-plate impinged on the base of the proximal fragment. This might result in increasing cortical screw tension thus causing breakage of all the screws holding the plate.[36] In our two cases of side-plate failure, the fracture was poorly reduced and resulted in delayed bone healing. With premature weight bearing, the tension force on the cortical screws was increased and failure of the fixation finally occurred.

In our study, there were no cases of deep vein thrombosis. The incidence of post-operative deep vein thrombosis in Asia was reported much lower than the western population.[5,35] Atichartakarn et al. and Chumnijarakij stated that routine prophylaxis of deep vein thrombosis in Thai patients was unnecessary due to less than 4% incidence after pelvis and lower extremity surgery.[1,7]

There were two cases of lag screw cut-out from the femoral head. Poor bone quality, improper screw location and an unstable fracture pattern might compromise the stability and lead to complications. Kim et al. reported a failure rate of more than 50% in osteoporotic, unstable fractures and recommended primary bipolar hemiarthroplasty for this group of patients.[21] On the contrary, Kaufer stated that bone quality, fracture pattern, fracture reduction, implant selection and implant placement were important factors regarding failure, but the last two were of relatively greater importance than the others.[20]

Conclusion

A four-hole side-plate DHS is commonly used in the treatment of intertrochanteric hip fractures. The major complication involves cut-out of the lag screw from the femoral head. Side-plate failure is uncommon and rarely reported. Biomechanic studies of a shorter side-plate shows that adequate stability is provided by fewer cortical screws. From our study, fracture collapse was associated with an osteoporotic unstable fracture pattern, improper fracture reduction and screw placement. The two-hole side-plate DHS is adequate for fixation of intertrochanteric hip fractures (Figs. 2 & 3).

References

1. Atichartakarn V, Pathepchotiwong K, Keorochana S, Eurvilaichit C. Deep vein thrombosis after hip surgery among Thai. Arch Intern Med 1988;148:1349—53.
2. Baumgaertner MR, Curtin SL, Lindskog DM. Intramedullary versus extramedullary fixation for the treatment of intertrochanteric hip fractures. Clin Orthop 1998;348:87—94.
3. Bendo JA, Weiner LS, Strauss E, Yang E. Collapse of intertrochanteric hip fractures fixed with sliding screw. Orthop Rev 1994;(Suppl.):30—7.
4. Bolhofner B, Russo P, Carmen B. Results of intertrochanteric femur fractures treated with a 135-degree sliding screw with a two-hole side-plate.. J Orthop Trauma 1999;13(1):5—8.
5. Cheng KK, Lai ST, Yu TJ, Kuo SM. Postoperative deep vein thrombosis in the Taiwanese Chinese population. Am J Surg 1987;11(2):174—7.
6. Christodoulou NA, Sdrenias CV. External fixation of intertrochanteric fractures with the single hip screw. Clin Orthop 2000;381:204—11.
7. Chumnijarakij T, Poshayachinda V. Postoperative thrombosis in Thai women Lancet 21 1975;1:1357—8.
8. Clawson DK. Trochanteric fractures treated by the sliding screw plate fixation method. J Trauma 1964;4:737—52.
9. Davis TRC, Sher JL, Hersman A, et al. Intertrochanteric femoral fractures; mechanical failure after internal fixation. J Bone Joint Surg 1990;72B:26—31.
10. Dean GL, David SG, Jason HN. Osteoporotic pertrochanteric hip fractures: management and current controversies. J Bone Joint Surg [Am] 2004;86:398—409.
11. den Hartog BD, Bartal E, Cooke F. Treatment of the unstable intertrochanteric fractures. Effect of the placement of the screw, its angle of insertion and osteotomy. J Bone Joint Surg [Am] 1991;73(5):726—33.
12. DiPaola M, Razbruch SR, Helfet DL. Minimal incision technique using a two-hole plate for fixation of stable intertrochanteric hip fractures. Orthopaedics 2004;27(3):270—4.
13. Doherty JH, Lyder JP. Intertrochanteric fractures of the hip treated with the hip compression screw—analysis of the problem. Clin Orthop 1979;141:184—7.
14. Ganz R, Thomas RJ, Hammerle CP. Trochanteric fractures of the femur—treatment and results. Clin Orthop 1979;138:30—40.
15. Gargan MF, Gundle R, Simpson AHRW. How effective are osteotomies for unstable intertrochanteric fractures. J Bone Joint Surg 1994;76:789—92.
16. Hardy DC, Descamps PY, Krallis P, et al. Use of an intramedullary hip screw compared with a compression hip screw

with a plate for intertrochanteric femoral fractures. J Bone Joint Surg [Am] 1998;80:618—30.
17. Harrington P, Nihal A, Singhanian AK, Howel FR. Intramedullary hip screw versus sliding hip screw for unstable intertrochanteric femoral fractures in the elderly. Injury 2002;33(1): 23—8.
18. Hoentjens P, Casteleyn PP, DeBoeck H, et al. Treatment of unstable intertrochanteric and subtrochanteric fractures in elderly patients. Primary bipolar arthroplasty compared with internal fixation. J Bone Joint Surg [Am] 1989;71(8): 1214—25.
19. Kamble KT, Murthy BS, Pal V, Rao KS. External fixation in unstable intertrochanteric fractures of the femur. Injury 1996;27(2):139—42.
20. Kaufer H. Mechanics of the treatment of hip injuries. Clin Orthop 1980;146:53—61.
21. Kim WY, Han CH, Park JI, Kim F JY. Failure of intertrochanteric fracture fixation with a dynamic hip screw in relation to preoperative fracture stability and osteoporosis. Int Orthop Springer Verlag; 2001, doi:10.1007/5002640100287.
22. Kourtzis N, Pafilas D, Kasimatis G. Mangement of pertrochanteric fracture in elderly patients with an external fixation. Injury 2001;32(Suppl. 4):115—28.
23. Koval KJ, Skovron ML, Poketsch D, et al. Dependency after hip fractures in geriatric patients: a study of predictive factors. J Orthop Trauma 1996;10:531—5.
24. Mainds CC, Neuman RJ. Implant failure in patients with proximal fracture of the femur treated with a sliding screw device. Injury 1989;20:98—100.
25. McLoughlin SW, Wheeler DL, Rider J, Bolhofner B. Biomechanical evaluation of the dynamic hip screw with two and four side-plates. J Orthop Trauma 2000;14(5):318—23.
26. Muller ME, Nazarian S, Koch P, Schatzker J. The comprehensive classification of fracture of long bones. Berlin, Germany: Springer-Verlog, 1990.
27. Phadungkiat S, Chiangthong K, Chariyalertsak S, Rajatanavin R. Incidence of hip fracture in Chiang Mai. J Med Assoc Thai 2002;85:565—71.
28. Rao JP, Banzon MT, Weiss AB, Rayhack J. Treatment of unstable intertrochanteric fractures with anatomic reduction and compression hip screw fixation. Clin Orthop 1983;175: 65—71.
29. Rodop O, Kiral A, Kaplan H, Akmaz I. Primary bipolar hemiarthroplsty for unstable intertrochanteric fractures. Int Orthop 2002;26(4):233—7.
30. Russel T. Fracture of hip and pelvis. In: Crenshaw AH, editor. 8th ed., Campbell's operative orthopaedics, vol. 2, 8th ed. St Louis: CV Mosby; 1992, p. 896—915.
31. Sarsthy MP, Madhaven P, Oomen M. Modified medial displacement and valgus osteotomy for unstable intertrochanteric fractures. Injury 1997;28(9—10):601—5.
32. Singh M, Nagrath AR, Maini PS. Changes in the trabeculae of the upper end of the femur as an index to osteoporosis. J Bone Joint Surg 1970;52:457—67.
33. Spivak JM, Zukerman JD, Kummer FJ, Frankel VH. Fatigue failure of the sliding screw in hip fracture fixation. J Orthop Trauma 1991;5(3):325—31.
34. Steinberg GL, Desai SS, Kornwitz NA, Sullivan TJ. The intertrochanteric hip fractures. Orthopaedics 1998;11:265—73.
35. Sudo A, Sano T, Honkawa K, Yamakawa T. The incidence of deep vein thrombosis after hip and knee arthroplasties in Japanese patients: a prospective study. J Orthop Surg 2003;11(2):174—7.
36. Wolfgang GL, Bryant NH, O'Neil JP. Treatment of intertrochanteric fractures of the femur using sliding screw plate fixation. Clin Orthop 1982;163:148—215.
37. Wu CC, Shih CH, Lee MY, Tai CL. Biomechanical analysis of location of the lag screw of a DHS in treatment of unstable intertrochanteric fractures. J Trauma 1996;41(4): 699—702.
38. Yian EH, Banerji I, Matthews LS. Optimal side-plate fixation for unstable intertrochanteric hip fractures. J Orthop Trauma 1997;11(4):254—9.
39. Yoshikmine F, Latta LL, Milne EL. Sliding characteristic of compression hip screw in intertrochanteric fractures: a clinical study. J Orthop Trauma 1993;7(4):348—53.
40. Zuckerman JD, Skovron ML, Koval KJ, et al. Postoperative complications and mortality associated with operative delay in older patients who have a fracture of the hip. J Bone Joint Surg [Am] 1995;77:1551—6.