

Conditions Affecting Treatment of Pertrochanteric Osteomyelitis

Chin-Hsien Wu, MD; Li-Jen Yuan, MD; Yi-Sheng Chan, MD; Alvin Chao-Yu Chen, MD;
Mel S. Lee, MD, PhD; Steven Wen-Neng Ueng, MD

Background: Although osteomyelitis following treatment of pertrochanteric fractures is rare, management can be difficult and often results in several physical and economic difficulties. Data regarding treatment of patients with pertrochanteric osteomyelitis is currently limited. This retrospective study evaluates the management of pertrochanteric osteomyelitis and presents our experience using a two-stage treatment protocol.

Methods: From 1984 to 1998, twenty-three pertrochanteric osteomyelitis cases were treated with a two-stage protocol comprising of an external skeletal fixator or Buck traction after radical debridement in the first stage and reconstruction in the second stage. The study included sixteen males and seven females with a mean age of 48.3 years (range 16-82 years). Patients were categorized as “successful” or “difficult” according to the number of operations they had undergone. Conditions including patient age, compromised host, interval before treatment, fracture severity, nonunion, hip joint involvement, multiple organisms and the presence of oxacillin-resistant *Staphylococcus aureus* were recorded for analysis.

Results: Only twelve of the twenty-three (52%) cases were successfully managed and infection recurred in four (17.4%) cases at final follow-up. Difficult cases managed by the two-stage protocol were more likely to be characterized by younger age ($p = 0.03$), unstable fractures ($p = 0.003$) and nonunions ($p = 0.027$).

Conclusion: The use of external skeletal fixation is not recommended for managing pertrochanteric osteomyelitis. Success using a two-stage protocol was difficult to achieve. Initial fracture severity should be carefully assessed when devising a treatment protocol for pertrochanteric osteomyelitis.

(*Chang Gung Med J* 2007;30:414-22)

Key words: pertrochanteric fractures, osteomyelitis

The surgical infection rate of pertrochanteric fractures is reported to be very low at 0%~2.2%.⁽¹⁻³⁾ Deep infection following pertrochanteric fracture is

difficult to diagnose because fever, local erythema and leukocytosis are not always present.⁽⁴⁾ If diagnosis and treatment are delayed, pertrochanteric infec-

From the Department of Orthopaedics, Chang Gung Memorial Hospital, Taipei, Chang Gung University College of Medicine, Taoyuan, Taiwan.

Received: Aug. 30, 2006; Accepted: Jan. 4, 2007

Correspondence to: Dr. Li-Jen Yuan, Department of Orthopaedics, Chang Gung Memorial Hospital, 5, Fusing St., Gueishan Township, Taoyuan County 333, Taiwan (R.O.C.) Tel.: 886-3-3281200 ext. 3882; Fax: 886-3-3278113; E-mail: lry51524@adm.cgmh.org.tw

tion is difficult to manage, and often results in severe physical and economic difficulties.^(4,5)

Data for treatment of patients with pertrochanteric osteomyelitis is extremely limited. In tibial and femoral osteomyelitis, debridement combined with antibiotic therapy and fracture stabilization using external skeletal fixation are generally the mainstays of treatment.⁽⁶⁻⁸⁾ The defect following radical debridement can be reconstructed using various methods, including cancellous bone grafting, local flap, pedicle flap, free microvascular flap and distraction osteogenesis in the second stage.⁽⁹⁻¹³⁾ After reviewing the favorable results we achieved in tibial and femoral osteomyelitis cases, this study applies the same concepts and a two-stage protocol to manage pertrochanteric osteomyelitis.

This study analyzes the management of pertrochanteric osteomyelitis and presents our experience with a two-stage treatment protocol.

METHODS

Between 1984 and 1998, twenty-three patients with pertrochanteric osteomyelitis were treated at the osteomyelitis department of the authors' hospital.

Table 1 summarizes the clinical information of the study population. There were 16 males and 7 females with a mean age of 48.3 years (range 16-82 years). Open fractures were noted in two cases and the rest were closed fractures. Fixation devices included Gamma nail in one (case 9) and dynamic hip screw (DHS) in the remaining twenty-two cases. In all cases, initial implants had been performed at other institutions and debridement for osteomyelitis had failed. The average interval between time of initial injury and presentation at our hospital was 9 months (range 1-62 months). During this interval, each patient had undergone one to four operations (average 1.2) to treat the pertrochanteric osteomyelitis. At the time of presentation, all patients had drainage sinuses and retained hardware. The bacteria responsible for the infection were isolated in one of two ways: preoperative biopsies or tissue samples at the time of debridement surgery. Oxacillin-resistant *Staphylococcus aureus* (ORSA) was cultured from seven patients; Enterococcus was cultured from six patients; *Staphylococcus aureus* was cultured from four patients; *Pseudomonas aeruginosa* was cultured from three patients;

Coagulase(-) staphylococci, Group B streptococci, *Serratia marcescens*, *E. coli* and anaerobic bacteria were cultured from two patients. Other pathogens included Group D streptococci, *Klebsiella pneumoniae*, *Proteus spp*, *Acinetobacter* and *Enterobacter cloacae*. Eight patients had multiple pathogens in the osteomyelitic bone. Two patients with gross purulence had negative cultures.

A two-stage treatment protocol was initially planned for these patients. The first stage included debridement and local antibiotic (organism specific) impregnated polymethylmethacrylate (PMMA) beads in conjunction with two weeks of parenteral antibiotics (organism specific). Buck traction or external skeletal fixation was used for stabilization of fracture sites. After each patient was discharged from the hospital, erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels were checked every two weeks. When ESR and CRP normalized, a second stage reconstruction (plating with cancellous bone grafting) was performed in eligible cases.

The severity of each fracture was classified as stable or unstable according to the Evans classification.⁽¹⁴⁾ Osteomyelitis was classified according to the Cierny and Mader system.⁽¹⁵⁾ According to the Seligson and Klemm classification for osteomyelitis, acute osteomyelitis occurs within the first 30 days, subacute osteomyelitis occurs from 1 to 6 months and chronic osteomyelitis occurs after 6 months.⁽¹⁶⁾ Generally speaking, the assessment of fracture healing relies on serial radiographic examinations with clinical correlation.^(17,18) However, radiographic union is frequently used as a study end point and can be an invaluable index when the findings of clinical examination are contradictory or unreliable. In this series, nonunion was defined as less than a 50% visible bridging callus across the fracture on plain radiographs.⁽¹⁹⁾

Since we planned to treat our patients using the two-stage protocol, the results of management were categorized as "successful" or "difficult" according to the number of operations required. Cases requiring up to two operations to eradicate the infection were categorized as "successful" due to non-recurrence of infection. Those requiring more than two operations were categorized as "difficult" because infection recurred after using the two-stage treatment protocol.

Statistical analysis was performed by SPSS ver-

Table 1. Clinical Information of Petrochanteric Osteomyelitis in 23 Patients

Case	Age/ gender	Fracture class*	Cierny-mader class	Injury	Comorbidity	Interval (months)	Fracture union	Bacteriology	No. of operations	External fixation	Protocol	Final result
1	64/M	U	IVB	Fall	DM	8	-	ORSA, Group B Streptococci, Coag(-) staphy	7	Yes	D	Recurrence
2	80/F	U	IVB	Fall	CVA	1	-	S. marcescens, K. pneumoniae	3	Yes	D	Cure
3	41/M	U	IVB	TA	Nil	5	-	Enterococcus	3	No	D	Cure
4	20/M	U	IVB	TA	Nil	9	-	S. aureus	3	No	D	Cure
5	16/M	U	IVB	TA	Nil	4	-	S. aureus	6	Yes	D	Recurrence
6	59/F	S	IIIA	TA	Nil	10	+	No growth	2	No	S	Cure
7	30/M	U	IVB	TA	Nil	6	-	ORSA	3	Yes	D	Cure
8	60/M	S	IVB	Fall	Nil	1	-	ORSA	6	No	D	Recurrence
9	21/M	U	IVB	TA	Nil	8	-	ORSA	3	No	D	Cure
10	41/M	U	IIIA	Osteotomy	Nil	2	+	P. aeruginosa	2	No	S	Cure
11	19/M	U	IIIA	TA	Nil	4	+	ORSA, Group B Streptococci	6	No	D	Recurrence
12	81/F	S	IIIA	Fall	Nil	4	+	Acinetobacter	1	No	S	Cure
13	31/M	U	IIIA	TA	Nil	15	+	ORSA	1	No	S	Cure
14	35/M	U	IIIA	TA	Nil	62	+	Enterobacter cloacae	1	No	S	Cure
15	55/F	S	IIIB	TA	DM	36	+	Enterococcus, P. aeruginosa, C. bifermentans	1	No	S	Cure
16	62/F	S	IVB	Fall	DM	12	-	S. aureus	1	No	S	Girdlestone
17	46/M	U	IVB	TA	Nil	6	-	S. aureus	7	No	D	Girdlestone
18	32/M	U	IVB	TA	DM	4	-	P. aeruginosa, E. coli. Group D Streptococci	9	No	D	Girdlestone
19	59/M	S	IVB	Fall	CVA, DM, LC	1	-	Enterococcus	2	No	S	Girdlestone
20	59/M	S	IVB	Fall	CVA, DM	2	-	Proteus spp, Serratia spp, Enterococcus	2	No	S	Girdlestone
21	57/M	S	IVA	TA	Nil	2	-	E. coli, ORSA, Enterococcus, B. thetaiotaomicron	2	No	S	THA
22	82/F	S	IVB	Fall	Nil	3	-	E. faecalis, Coag(-) staphy	2	No	S	Girdlestone
23	63/F	S	IVB	Fall	DM	5	+	No growth	2	No	S	THA

Abbreviations: U: unstable; S: stable; TA: traffic accident; DM: diabetes mellitus; CVA: cerebrovascular accident; LC: liver cirrhosis; ORSA: oxacillin-resistant Staphylococcus aureus; Coag(-) staphy: coagulase-negative staphylococci; S. marcescens: Serratia marcescens; K. pneumonia: Klebsiella pneumoniae; C. bifermentans: Clostridium bifermentans; D: difficult; S: successful; THA: total hip arthroplasty; *: Evans classification.

sion 10. The ages of the patients in the successful group and the difficult group were compared by independent t-test. Compromised host, interval before treatment, fracture severity, fracture nonunion, hip joint involvement, multiple organisms and the presence of ORSA were compared by Fisher tests. A two-tailed value of $p < 0.01$ was considered statistically significant.

RESULTS

In the two-stage treatment protocol for petrochanteric osteomyelitis, an “infection eradication first” strategy was adopted rather than a “union first” strategy. Unfortunately, only twelve out of twenty-three (52%) cases were successfully managed by the two-stage protocol (Fig. 1). Patients who were successfully managed by the two-stage protocol were



Fig. 1 Case 1. A 64-year-old male with diabetes had suffered from right pertrochanteric osteomyelitis for 8 months. (A) At presentation, the fracture was classified as an unstable Evans type with IVB (Cierny and Mader) osteomyelitis. (B) External fixation failed to stabilize the fracture with severe pin-track infection and loosening. (C) The patient then underwent multiple procedures to control infection. (D) The pertrochanteric infected nonunion healed after 7 operations.

compared with those managed with difficulty (Table 2). The average follow-up period was 55 months (range 24-156 months). At final follow-up, four (17.4%) cases (cases 1, 5, 8, and 11) revealed recurrence of osteomyelitis. Eight cases (cases 16 to 23)

underwent Girdlestone operations for their septic hips. Two cases were successfully managed by cemented total hip arthroplasty at the second stage (Fig. 2) after Girdlestone operation (cases 21 and 23), and the rest refused further surgery.

Table 2. Conditions Affecting Management Results

	Successful (n = 12)	Difficult (n = 11)	<i>p</i> *
Age (years)	57 ±15.6	39 ±21.	0.03 [†]
Host (Cierny-Mader) Compromised Host	6 (50%)	10 (91%)	0.069 [‡]
Interval before treatment (> 6 months)	5 (42%)	5 (46%)	1.000 [‡]
Fracture severity (unstable Evans type)	3 (25%)	10 (91%)	0.003 [‡]
Fracture nonunion	5 (42%)	10 (91%)	0.027 [‡]
Hip joint involvement	6 (50%)	2 (18%)	0.193 [‡]
Multiple organisms	4 (33%)	4 (36%)	1.000 [‡]
Presence of ORSA	2 (17%)	5 (46%)	0.193 [‡]

Abbreviations: ORSA: oxacillin-resistant *Staphylococcus aureus*; *: A two-tailed value of $p < 0.01$ was considered statistically significant; †: analyzed using an independent t-test; ‡: analyzed using a Fisher's test.

Host factor

Although there was no significant difference in the ages of patients in the two groups, the difficult group tended to be younger ($p = 0.03$). The host status of the patients, subdivided according to the Cierny and Mader classification, did not significantly differ between the two groups ($p = 0.069$).

Duration of osteomyelitis (acute and subacute/chronic)

Patients were subdivided into two groups according to the interval of time occurring before referral to our osteomyelitis department.⁽¹⁶⁾ However, duration of osteomyelitis did not statistically differ between the two groups ($p = 1.000$).

Local biomechanical condition (fracture severity and nonunion)

Initial fracture severity was classified according to the Evans classification. Patients with unstable fractures were more likely to be difficult to treat by the two-stage protocol ($p = 0.003$). Additionally, ten out of fifteen cases with infected nonunion failed to respond to the two-stage protocol ($p = 0.027$).

Hip joint involvement

Eight patients suffered infections extending into their hip joints. Delayed diagnosis in two patients resulted in multiple procedures being required to arrest the infection. Girdlestone operations successfully arrested the infection in the remaining six patients. Early diagnosis and immediate Girdlestone operation were essential in patients with hip joint

involvement. Hip joint involvement demonstrated no statistically significant relationship to management results ($p = 0.193$).

Bacteriology

ORSA was cultured from seven patients. Eight patients had multiple pathogens in the osteomyelitic bone. The presence of multiple causative organisms and ORSA had no statistically significant effect on management results ($p = 1.000$ and $p = 0.193$, respectively).

Finally, only fracture severity was a significant predictive factor affecting management results ($p = 0.003$).

Complications

All patients with external skeletal fixation (four cases) experienced loosening of the external skeletal fixators. One patient with knee flexion contracture required surgical intervention. Six patients had leg length discrepancy (exceeding 2 cm). Refractures were noted in two cases: one was caused by a traffic accident and the other was caused by a fall.

DISCUSSION

Osteomyelitis of pertrochanteric fractures is rare and treatment can be extremely challenging.^(3,4,20) Cierny and Mader sub-classified osteomyelitis physiologically: an "A" host is an otherwise healthy subject, a "B" host is a subject with either systemic or local factors that might compromise the treatment result and a "C" host is defined as "treatment worse

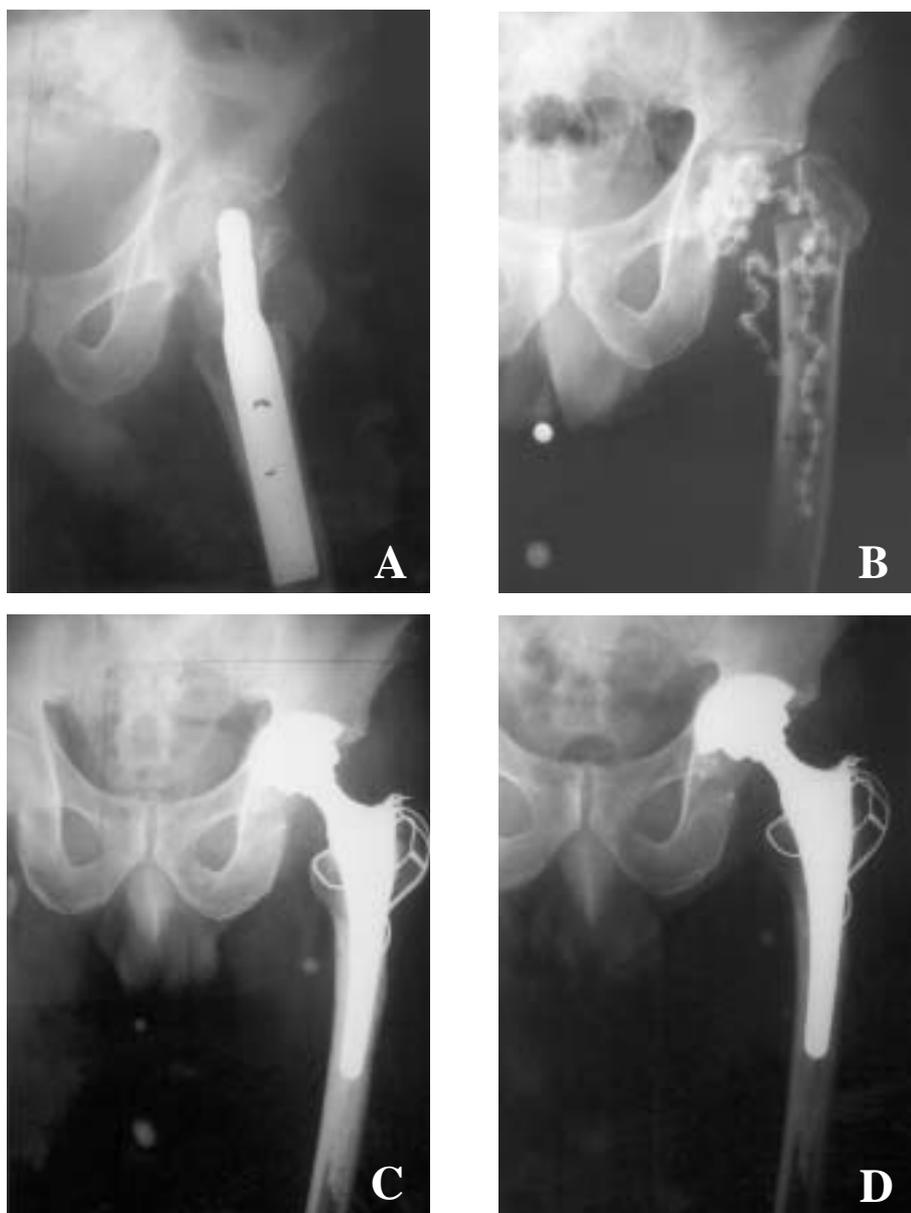


Fig. 2 Case 23. A 57-year-old male had progressive worsening left hip pain and drainage sinus for 5 months. (A) A pertrochanteric fracture with a septic hip was diagnosed based on an obliterated joint space. (B) A Girdlestone operation successfully controlled the infection. (C) At the second stage (3 months later), hybrid total hip arthroplasty, using vancomycin impregnated polymethylmethacrylate for femoral component fixation, was performed. (D) At the final visit (2 years postoperatively), no reactivation of infection was observed.

than the disease".⁽¹⁵⁾ Previous well-documented studies have revealed that the condition of the host and anatomic type of osteomyelitis affects the prognosis but does not differ between acute and chronic processes.^(15,21) The host status did not significantly differ between the two groups in this study ($p =$

0.069). However, ten out of fifteen cases with infected nonunion (diffuse osteomyelitis) failed to respond to the two-stage protocol ($p = 0.027$). The two groups did not significantly differ in duration of osteomyelitis ($p = 1.000$). Although the ages of the patients in the two groups did not significantly differ,

the difficult group tended to be younger ($p = 0.03$). Petrochanteric fractures occur less frequently in young patients and they are more often unstable fractures due to high-energy injuries, such as traffic accidents. A poor soft tissue condition or an unstable fracture may adversely affect the results.

The use of external fixation is the preferred strategy in most osteomyelitic cases, and is effective in stabilizing fractures in cases of infected nonunion in tibial and femoral osteomyelitis.^(7,8) Although Barros reported satisfactory results using external fixations on complicated cases with intertrochanteric fractures,⁽²²⁾ severe pin-track infection and fixation failure after using external fixation during the interim period before reconstruction was encountered in this study. These complications required additional procedures to control infection. External skeletal fixation has been reported to have a high incidence of nonunion in type III open femoral fractures.⁽²³⁻²⁵⁾ Notably, the incidence of infection is very high (30%~100%) when the external fixation is replaced by internal fixation. By joining the lower extremities with the trunk, the petrochanteric area of the hip sustains high levels of mechanical stress during daily locomotion and while maintaining an upright posture. External fixation that bypasses the bone gap after debridement is unlikely to be able to sustain such high levels of mechanical stress across the petrochanteric area, and pin-track infection often occurs because of poor drainage of discharge from the femur. Therefore, external skeletal fixation is not recommended for management of petrochanteric osteomyelitis.

In this study, only 12 out of 23 (52%) cases were successfully managed by the two-stage protocol and, at final follow-up, four (17.4%) cases presented with recurrence of osteomyelitis. Some surgeons have treated infection after intramedullary nailing of the femur using both the "infection eradication first" and "union first" strategy, and the "union first" group obtained better results.⁽²⁶⁾ The "union first" strategy may be more effective for treating infected nonunion of petrochanteric fractures. However, it requires further clinical experience and a larger series.

Petrochanteric osteomyelitis with hip joint involvement is not uncommon. This condition was noted in 34.8% (eight out of 23) of the patients in this study. For infection control, a Girdlestone operation is required to eradicate all devitalized tissue,

including the femoral head and the acetabular cartilage. In procedures performed earlier, delayed diagnosis of septic hip led to the necessity for multiple procedures to arrest the infection (cases 17 and 18). A high index of suspicion and careful examination for septic hip is necessary for adequate management of petrochanteric osteomyelitis. An antibiotic-loaded interim cement prosthesis is currently being used for hip infection but requires further long term study to evaluate the results.⁽²⁷⁾

A limitation of this study is the small number of cases. However, fracture severity (stable/unstable) affects the management of petrochanteric osteomyelitis. In conclusion, osteomyelitis of petrochanteric fractures is a rare and challenging condition to treat. Success using a two-stage protocol is difficult to achieve, despite contemporary debridement techniques, intravenous antibiotics and delayed reconstruction. Initial fracture severity should be carefully assessed when devising a treatment protocol for petrochanteric osteomyelitis.

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股骨轉子骨間骨髓炎使用兩階段療程治療結果及預後因子探討

吳金獻 袁立仁 詹益聖 陳昭宇 李炫昇 翁文能

背景：雖然股骨轉子骨間骨折併發骨髓炎的發生率很低，但此種狀況一旦發生，治療卻非常困難。綜觀文獻，少有關於股骨轉子骨間骨髓炎治療之論述，本篇回溯性之研究主在分析股骨轉子骨間骨髓炎使用兩階段療程治療結果及預後因子探討。

方法：自西元 1984 年到西元 1998 年，23 個股骨轉子骨間骨髓炎患者經兩階段療程治療，第一階段實行徹底清創，繼以骨外固定器或皮膚牽引治療，第二階段實行重建。共有 16 名男性及 7 名女性，病患平均年齡為 48.3 歲 (範圍, 16-82 歲)。病患依接受手術次數多寡歸類為治療成功及治療困難兩組，且將病患年齡、病患健康狀態、發病到治療時間、骨折嚴重程度、骨折未癒合、合併髖關節感染、多重致病菌感染，及抗藥性金黃色葡萄球菌感染等因子列入預後因子評估。

結果：23 個病患中有 12 個人 (52%) 以兩階段療程成功治療，最後追蹤時共有 4 人 (17.4%) 感染復發。當病患有年紀較輕 ($p = 0.03$)，不穩定性骨折 ($p = 0.003$)，或骨折未癒合 ($p = 0.027$) 時經兩階段療程治療後，有較高機率導致治療困難結果。

結論：在治療股骨轉子骨間骨髓炎時，我們並不建議使用骨外固定器。使用兩階段療程並不易成功治療。當要構思新的股骨轉子骨間骨髓炎之治療流程時，須將病患骨折嚴重程度列入考量。

(長庚醫誌 2007;30:414-22)

關鍵詞：股骨轉子骨間骨折，骨髓炎

長庚紀念醫院 台北院區 骨科部；長庚大學 醫學院

受文日期：民國95年8月30日；接受刊載：民國96年1月4日

通訊作者：袁立仁醫師，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3882; Fax: (03)3278113;

E-mail: lry51524@adm.cgmh.org.tw