

出國報告（類別：參加國際醫學會議發表論文）

**世界足踝骨科醫學會暨美國足踝骨
科年會**

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摘要

此次出國參加三年一度的世界足踝醫學大會暨美國骨科足踝醫學年會，並在會中發表論文。論文以英文發表，題目為：ORIF of acute intra-articular displaced calcaneal fractures: A retrospective analysis of surgical timing and infection rates

以下是此篇論文之英文摘要

Introduction: The choice of surgical timing in open reduction for calcaneal fractures has been proposed to be associated with soft tissue complications and infection. This study analyzed the correlation between surgical timing and infection rates. We performed a retrospective single- surgeon single-facility study between Jan 2006 and Jan 2010. 50 patients with 53 intra-articular calcaneal fractures were included. They received open reduction internal fixation via extensile lateral L-shaped approach.

Methods: We assessed the duration between heel trauma and operation from the medical records and sorted our patients into early (within 3 days), intermediate (from 3 to 10 days) and delayed (over 10 days) surgical groups. The mean follow-up period was 13 months.

Results: Only one of the 50 patients, a 74-year-old female with diabetes mellitus , developed deep infection requiring hardware removal and debridement. overall, we did not find a statistical difference in postoperative infection rates in the different timing groups.

Conclusion: Our conclusion is that in experienced hands, surgical timing may not affect postoperative infection rates in calcaneal fracture among strictly selected patients who do not have potential risk factors for wound complication. Therefore, early operation may be helpful to this patients

目的

此次出國參加三年一度的世界足踝醫學大會暨美國骨科足踝醫學年會，並在會中發表論文。同時在會議中與來自世界各地的足踝專科醫師互相討論，吸取這方面的最新知識。除了演講討論的交流之外，會場亦有各種最新的儀器和醫療器材展示，參觀這些足踝骨科醫療器材的新進展，亦是此行的目的之一。

過程

此次世界足踝醫學大會舉行地點在美國芝加哥，這次醫學會與美國足踝年會同時舉辦，與會醫師總共有一千多人。台灣醫師代表除了我代表衛服部屏東醫院以外，還有陳姝蓉醫師，高醫的黃鵬如醫師，阮綜合醫院的阮璿儀醫師，可以說這次代表台灣參加這場國際會議的醫師幾乎都來自南台灣，均與我有師生之誼，也是此行的特點之一。



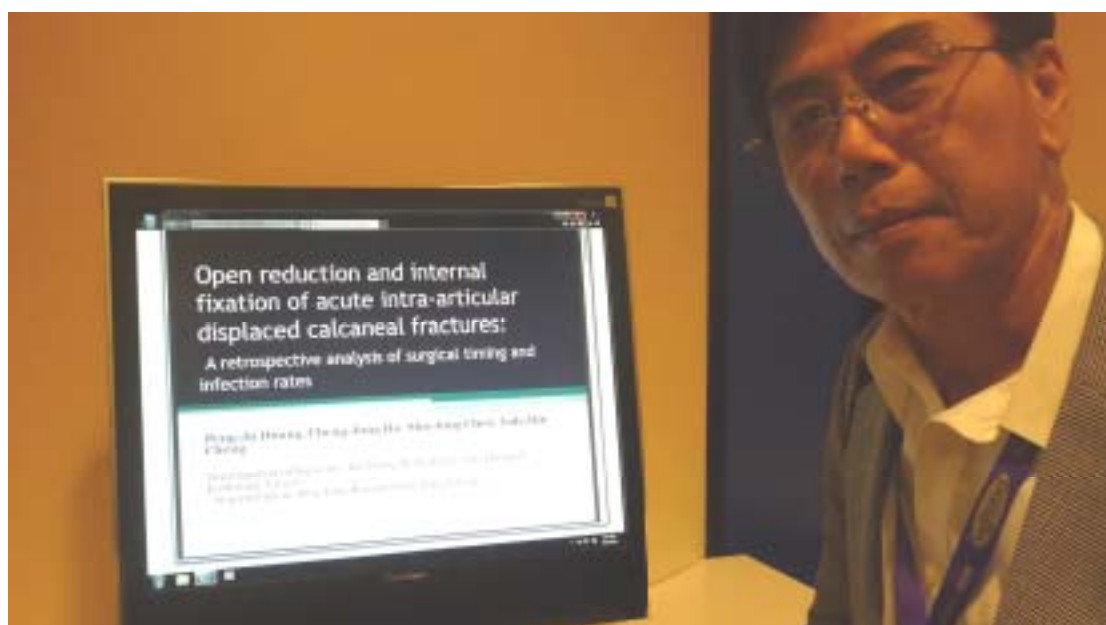
攝於世界足踝骨科醫學會暨美國足踝骨科年會會場

這次會議我發表壁報論文，題目是：

ORIF of acute intra-articular displaced calcaneal fractures:

A retrospective analysis of surgical timing and infection rates

這篇臨床研究論文已經刊登在injury這一本知名國際期刊上，主要是探討急性跟骨骨折在開刀時間的選擇與感染併發症發生機率上是否有相關性。根據我們收集分析的資料做統計分析之後發現：施行跟骨骨折復位鋼板內固定以往被認為是併發症比較多的一種手術，有醫學報告指出皮膚壞死與感染等併發症在少於受傷三天內就接受手術的病人會比較常發生，但我們統計的結果並沒有呈現這種相關性。相反的，我們發現三天內接受手術與大於七天再接受手術的兩組病人，其皮膚感染或壞死的發生率在統計學上並沒有明顯差異。



這個臨床統計結果可以對目前台灣受限于全民健保對住院天數與臨床路徑有嚴格限制下一個比較有科學根據的治療基準。以往因為教科書上都建議需等七天到十四天才能施行開刀骨折復位內固定手術，以避免併發症發生的機會，現在我們有了這一臨床研究做基礎，就可以放心的在沒有risk factor的病人身上提早做開刀手術，不需要病人住院後還要等一星期後才能開刀，這樣可以縮短住院時間，恢復時間也比較快。

心得及建議

這次參加世界足踝醫學大會，心中有一些感觸與心得。在會場我們可以看到踝關節人工關節發展日新月異，可是在我們身處的台灣，全踝人工關節目前只有Wright公司引進比較早的型號。這類型的人工踝關節需要切除較多的脛骨，而切除骨頭較多的後遺症就是容易有植入物鬆脫的問題，而且台灣現在也沒有把全踝人工關節納入健保給付，使得台灣的踝關節炎患者不但必須自費，但得到的並不是最先進的產品。比照韓國醫師在會場發表的論文，他們在病例數目與人工關節種類的選擇上就比台灣多很多。台灣一直自豪的全民健保制度到底是處進了醫療的發展還是阻礙了國內醫療的進步，是值得我們深思的問題。

Open reduction and internal fixation of acute intra-articular displaced calcaneal fractures: A retrospective analysis of surgical timing and infection rates

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ABSTRACT

The choice of surgical timing in open reduction for calcaneal fractures has been proposed to be associated with soft-tissue complications and infection. This study analysed the correlation between surgical timing and postoperative infection rates. We performed a retrospective single-surgeon single-facility study (Kaohsiung Medical University Hospital, KMUH) between January 2006 and January 2010. Fifty patients with 53 close intra-articular calcaneal fractures were included. They received open reduction and internal fixation via the extensile lateral L-shaped approach. We assessed the duration between heel trauma and operation from the medical records and sorted our patients into early (within 3 days), intermediate (from 3 to 10 days) and delayed (over 10 days) surgical groups. The mean follow-up period was 13 months. Only one of the 50 patients, a 74-year-old female with diabetes mellitus, developed deep infection requiring hardware removal and serial debridement. Overall, we did not find a statistical

difference in postoperative infection rates in the different timing groups. Our conclusion is that in experienced hands, surgical timing may not affect postoperative infection rates in calcaneal fracture among strictly selected patients who do not have potential risk factors for wound complication. Therefore, early operation may be helpful to these patients.

Soft-tissue management is one of the most challenging tasks in calcaneal fracture surgery. Recent evidence has shown satisfactory clinical outcomes with reconstruction of the displaced articular surface of the calcaneum.^{1–4} However, difficulty in reducing calcaneal facet joints and soft-tissue complications is frustrating for trauma surgeons. Previously published clinical series have reported that deep infection rates with open reduction and internal fixation in calcaneal fractures have ranged from 13.5% to 21%.^{5–7} Efforts have been made to identify causative factors in these postoperative complications. Many factors, including institutional fracture loads,⁸ the surgeon's personal surgical experience,⁹ smoking,⁶ fracture severity and surgical timing, have been proposed. In order to reduce soft-tissue complications, many surgeons have postponed the operation until the soft-tissue swelling regresses or the patient has a positive 'wrinkle test',¹⁰ usually 10–21 days after the initial trauma. On the other hand, some authors have argued that prolonged surgical delay may increase postoperative infection rates in calcaneal fracture surgery.^{5,11,12} To delineate the relationship between infection and timing of surgery, we conducted a retrospective analysis sorting calcaneal fracture operations according to their surgical timing.

Methods and patients

We performed a retrospective analysis of patients who underwent open reduction and internal fixation of calcaneal fractures at Kaohsiung Medical University Hospital (KMUH) between January 2006 and January 2010. This project was approved by the institutional review board.

On admission, we recorded the trauma aetiology and exact timing of every patient. Thorough physical examinations were performed to rule out open fractures and to evaluate initial heel soft-tissue conditions. All the patients had pre-operative plain radiograph and computed tomography examinations to confirm and grade the displacement of the calcaneal facet joints.

We retrospectively selected patients of all ages who presented at KMUH between January 2006 and January 2010 with confirmed intra-articular calcaneal fractures. The included patients had undergone open surgical reduction and internal fixation via the lateral extensile L-shaped approach performed by a single experienced surgeon (PJH). The selected implant was the AO calcaneal plate (Stratec Medical Ltd., Welwyn Garden City, UK). We excluded patients with calcaneal open fractures, fractures with concomitant heel degloving injuries or contaminated heelpenetration wounds. We also excluded patients with established contraindications to open calcaneal surgery, such as insulindependent diabetes mellitus, severe neurovascular insufficiency and immunodeficiency.¹³ Patients with calcaneal fractures from high-energy trauma often have simultaneous injuries to the pelvis, thorax, spine and head. Therefore, we postponed calcaneal fracture surgery in patients with altered consciousness, unstable haemodynamics and an initial injury severity

score > 16. Patients with isolated calcaneal fracture without surgical contraindications would be scheduled for calcaneal open reduction and internal fixation within 48 h after informed consent was given. All these surgical candidates received inpatient treatment protocol, including compressive dressings, injured limb elevation, cryotherapy and strict bed rest. Fracture blisters are common in high-energy heel trauma and may become a major problem in peri-operative soft-tissue management. Therefore, we carefully explored for fracture blisters before operation. Surgery was postponed until re-epithelialisation, when blisters were noted on the surgical incision line. If direct incision on the blister base could be avoided, the operation was carried out according to schedule (Fig. 1). Both serous and haemorrhagic blisters were managed with the same strategy.

We calculated the interval between the trauma event and the operation from the medical records and divided the patients into three groups based on this timing (Table 1). The early-operation patients were operated on within 72 h after injury; the intermediate group received surgery between 72 h and 10 days; and the patients in the late operation group had surgical delays of more than 10 days.

In the operating room 30 min before the operation, we routinely administered 1 g intravenous cefazolin for prophylaxis. Injured limb exsanguination and tourniquets were applied to reduce bleeding. We used the lateral L-shape extensile incision directly on the periosteum without subcutaneous stripping.¹⁰ We avoided direct incision on a blister that might result in rapid colonisation by a pathogen on a non-epithelialised blister bed.¹⁴ The AO calcaneal plate and screws were used for all

patients. No bone grafts or drain tubes were emplaced. Dual-layer skin closure was performed with subcutaneous absorbable sutures and skin staples or superficial nylon sutures. Before leaving the operating room, a bulky aseptic dressing was applied to the injured heel to absorb excessive oozing after surgery. We used short leg plaster splints in all patients.



Fig. 1. This is the picture of a 68-year-old female who received open reduction and internal fixation of her left intra-articular calcaneal fracture in the early operated group. On the 15th day post operation we removed the stitches and took this picture. Note the round eschar which was the result of pre-operative hemorrhagic blisters. It should be emphasized not to incise directly onto the blister bed in the vertical incision line.

Table 1

Demographic characteristics of the 3 groups (Group I: early-operation group; Group II: intermediate group; and Group III: delayed operation group).

		Group I	Group II	Group III
Case numbers		30	10	10
Heel numbers		32 (60.38%)	11 (20.75%)	10 (18.87%)
Average age		44.81	40.91	46.6
Gender	Male	21 (65.6%)	7 (63.6%)	8 (80%)
	Female	11 (34.4%)	4 (36.4%)	2 (20%)
Injured side	Right	13 (40.6%)	3 (27.3%)	3 (30%)
	Left	19 (59.4%)	8 (72.7%)	7 (70%)
Sander classification	Type II	21 (65.6%)	5 (45.4%)	5 (50%)
	Type III	8 (25%)	3 (27.2%)	3 (30%)
	Type IV	3 (9.4%)	3 (27.2%)	2 (20%)
Infection numbers		1 (3.1%)	0	0

On the first postoperative day, all patients received four doses of prophylactic cefazolin (1 g) by intravenous injection at intervals of 6 h. The wound would be opened and carefully re-assessed on the second day after operation. Patients were discharged on the third to fifth day after surgery. The superficial sutures were removed during the third week post-operation in the outpatient department (OPD). The patients were followed up in our OPD for wound care and functional assessment, and later, if they could not make the OPD visit, we followed up their condition with phone calls.

We defined infection as persistent wound discharge after removal of stitches, conditions requiring surgical debridement, hardware removal, or prolonged antibiotic use after the initial four postoperative doses. We also defined wound dehiscence, heel or full-thickness wound-edge necrosis

and conditions requiring flap reconstruction as positive results. Superficial wound-edge breakdown confined to the epidermal layer was not considered a positive wound complication.

Results

Between January 2006 and January 2010, 91 patients presented at KMUH with calcaneal fractures and underwent operation. Of the 91 patients, 57 received surgical treatment by our senior author (PJH) and were included. Six of the 57 patients had bilateral heel injuries, resulting in 63 displaced intra-articular calcaneal fractures. We excluded five open calcaneal fractures. We also excluded one patient with a concomitant degloving injury requiring flap and skin-graft reconstruction. Two patients underwent percutaneous pinning and two others received direct subtalar fusion due to prolonged delay before surgery (over 45 days). After the exclusions, 50 patients and 53 heels were enrolled in this retrospective study. The mean follow-up was 13 months (ranging from 8 months to 2 years).

The average age of the selected patients was 45 years (standard deviation (SD) = 14, ranging from 19 to 84 years). Of the injured heels, 34 were on the left side and 19 on the right. Nineteen patients (38%) were smokers. The two major trauma aetiologies were falling from a height (21 patients with 24 heels) and traffic accidents (29 patients with 29 heels). Eight heels had pre-operative fracture blisters. Haemorrhagic blisters were noted in three patients. Since some fracture blisters appeared even after the operation, documentation of the quantity, location, size and types of

blisters became difficult. A 54-year-old male presented with blisters directly on the planned surgical incision lines and therefore the surgery was postponed for 13 days. Six patients had delayed surgery due to trauma from falling and a high injury severity score of more than 16 at the initial presentation. Four of the enrolled patients had diabetes with oral medical control. Two had hepatitis C-related liver cirrhosis that was classified as Child A, but they did not have hypoalbuminaemia or coagulation disorders. No patients had an auto-immune disease or end-stage renal failure requiring dialysis.

Within the timing framework described above, there were 30 patients with 32 heels in the early operated group, 10 patients and 11 heels in the intermediate group and 10 patients with 10 heels in the delayed group. Patients were sorted into the three groups based on their time of presentation at our facility, except those who were delayed due to major trauma and fracture blisters. We followed up our patients in the OPD at an interval of 3 months in the first year post operation. The mean follow-up period was 13 months (from 12 months to 4 years). Fourteen patients could not make the 1-year follow-up in our OPD and received a detailed clinical questionnaire by phone calls. Among all the patients, only one heel had a positive infection event. This patient was a 74-year-old female in the early-operation group who presented with left calcaneal fracture from a traffic accident. She had underlying diabetes with regular oral hypoglycaemic agents and good medical compliance. Her HbA1c level was 7.8% in the routine examination 1 month before the trauma event. Her calcaneal fracture was classified as Sanders type II. After the surgery, wound dehiscence and persistent serous discharge were

noted during hospitalisation.

We lengthened the period of intravenous antibiotic to 5 days. However, her wound did not seem to be improving. Three weeks after initial surgical treatment, she was admitted again due to purulent wound discharge and implant exposure. Wound culture yielded *Staphylococcus aureus*. Surgical debridement and implant removal were performed immediately. Her wound improved and gradually healed after implant removal and wound care.

Discussion

Intra-articular calcaneal fractures are usually the consequence of axial loading on the subtalar joints.¹⁰ A displaced calcaneal facet joint may lead to abnormal subtalar joint contact pressure, limited hindfoot range of motion and subtalar osteoarthritis. Current evidence has shown satisfactory clinical results in surgically treated calcaneal fractures.^{2,3} Empirical evidence suggested that restoration of the calcaneal anatomy is the only way the patient can have a normal gait.¹⁵ Brauer et al.¹⁶ also described the economic benefit of calcaneal fracture surgery. However, the majority of these fractures result from high-energy trauma, such as falling from a height or traffic accidents. High-energy trauma and the relatively thin coverage of soft tissue on the heel may lead to severe soft-tissue compromise. The soft-tissue complications and infection of open calcaneal surgery remain problematic. The reported infection rates of open reduction with internal fixation in calcaneal fracture were 0–20%.¹⁷ Folk et al.⁶ reported 20% deep infection rates in 190 calcaneal fractures, but they included insulin-dependent patients and open fractures.

Benirschke and Kramer¹⁷ in a retrospective review of 341 close calcaneal fractures, reported a 1.8% serious infection rate with open reduction and internal fixation via a lateral extensile approach. They concluded that in compliant patients, open reduction did not expose the patients to undue surgical infection rates.

In this study, we assessed the correlation of surgical timing and infection rates in calcaneal fractures. Of our 50 patients, only one in the early-operation group had a positive soft-tissue infection requiring debridement and hardware removal. The overall infection rate was 1.88%. This excellent result is multifactorial. We excluded patients with open fractures and established contraindications, such as severe neurovascular insufficiency, insulin-dependent diabetes mellitus, poor compliance, immunodeficiency and severe systemic disease with a poor overall outcome.¹³ Superficial wound-edge breakdown (Fig. 2) with eschar formation was not deemed a positive complication, because the superficial eschar requires routine wound care rather than prolonged antibiotic use or debridement. No patient had severely compromised liver or renal function that would alter the treatment protocol.¹⁸ The smoking rate of our patients was relatively low (38%) compared with Folk's analysis (62.1%).⁶ All patients were operated on by a single high-volume foot-ankle surgeon, who had performed over 150 calcaneal-fracture surgeries prior to this project. In this study, the average tourniquet time of Sander type II calcaneal fractures was 48.2 min (from 39 to 56 min), 50.4 min (from 38 min to 69 min) in Sander type III fractures and 58.5 min (from 44 to 101 min) in Sander type IV fractures. All patients had a tourniquet time of <1.5 h, except one patient classified as Sander type IV.

A tourniquet time of <1.5 h was recommended¹⁹ to reduce soft-tissue complications in calcaneal fractures. We used an inpatient protocol for all patients who received calcaneal-fracture surgeries. An inpatient protocol can allow earlier operative intervention and effectively reduces wound complications.²⁰ The project was carried out at KMUH, which had an institutional fracture load of around three per month in the past decade. A multivariate analysis found a significantly inverse correlation between the institutional fracture load and deep-calcaneal surgical-infection rates.⁸ Therefore, we believe that the low infection rates in calcaneal-fracture surgery are reproducible in a high-volume institution with an experienced surgeon and strict patient-selection criteria.



b



Fig. 2. (a) A 48-year-old male presented with Sander type III intra-articular calcaneal fracture. Note the great step-off of the subtalar joint. (b) This is the post-operative plain film of the same male patient. The subtalar joint was reduced with good alignments.

The correlation between the timing of calcaneal-fracture surgery and infection remains an unsettled issue.^{10–12} In this retrospective analysis, the only patient with infection was in the early-operation group, which had the most case numbers. From this, we infer that early operation in displaced intra-articular calcaneal fractures in selected patients with

similar exclusion criteria, as in this analysis, will not increase surgical-infection rates. A safe treatment window may exist in early open calcaneal-fracture surgery similar to that proposed by Tim et al. in tibial pilon fractures.²¹ The limitation of this study is that our sample size was insufficient to provide significant statistical power between the three surgical-timing groups. We designed the study as a single surgeon, single-facility analysis. We also confined the cases to the most recent 5 years to minimise bias from different operation teams, hardware, treatment protocols and the institutional antibiotic-sensitivity spectrum. However, of the 30 patients with 32 injured heels in the early-operation group, only one had postoperative infection. The overall infection rate in the early operation group was 3.1%, which does not represent an elevated infection rate.

Our conclusion is that early operation in strictly selected patients by experienced surgeons may not increase surgical infection rates. Therefore, early operation could be one helpful way to treat patients with displaced intra-articular calcaneal fractures without potential risk factors of wound complication.

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