Perkins traction for adult femoral shaft fractures: a report on 53 patients in Sierra Leone

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Abstract A retrospective study of 53 consecutive adult patients with 54 femoral shaft fractures treated with Perkins traction over a 25-month period was carried out. Mean length of stay was 52.1 days (range 25–108), and mean duration of traction was 45.0 days (range 23–66). At a mean follow-up of 4.6 months (range 3–9), 50 (92.6%) had healed and 5 (9.3%) had a malunion. There were 4 (7.4%) non-unions, 3 (5.5%) had shortening of more than 2.5 cm and 2 (3.7%) had a re-fracture. The rate of pin tract infection was very high at 42.6% (23 patients).

Résumé Etude rétrospective de 53 patients consécutifs sur 25 mois, présentant une fracture de la diaphyse fémorale traités par une traction selon Perkins. La durée moyenne de traction était de 45 jours (23–66) et la durée d'hospitalisation de 52.1 jours (25–108). A un délai moyen de 4.6 mois (3–9), 50 fractures (92.6%) étaient consolidées, 5 (9.3%) avec cal vicieux. Il y avait 4 (7.4%) non consolidation, 3 (5.5%) avaient un raccourcissement de plus de 2.5 cm et 2 (3.7%) avaient une fracture itérative. Le taux d'infection sur broche était très élevé, à 42.6% (23 patients).

Introduction

There has been very little written over the last 30 years on the conservative management of femoral shaft fractures in

the adult. In the 1970s, developed countries saw a transition toward the surgical treatment of these fractures [10]. There seems to be little doubt that surgical fixation, all else being equal, gives better results than conservative treatment, in terms of anatomical and functional outcomes, complication rates, and even costs, particularly in the polytraumatised patient [5, 8, 10, 15]. This is true of high income, developed countries, where almost all the studies have been carried out, but not necessarily the case for poorer nations. The lack of well-trained surgeons and other health care providers, of appropriate and affordable equipment and implants, and of reliably clean surgical environments increases the risks of surgical complications of orthopaedic procedures often to unacceptable levels. Conservative management of femur fractures with traction remains the best and very often the only option for resource-poor countries.

Traction has been used for centuries and all the different techniques are based on the same underlying principle: alignment of a long bone fracture can be achieved and maintained by continuous pulling (isotonic traction) on the soft tissue envelope along its longitudinal axis [17]. In general, skeletal traction is preferred to skin traction for adult femoral shaft fractures. Different configurations, with or without suspension or frames, have been advocated: straight longitudinal (Buck) [14], with rigid frame (Bohler-Braun) [17], or some combination of mobility and suspension, such as those of Thomas-Pearson [4] or Russell [1]. The textbook by Sir John Charnley on the closed management of fractures remains to this day classic reading on the matter [7].

Among the proponents of traction, one area in particular has long been controversial: does movement at the fracture site promote or prevent bone healing? Rest and immobilisation was advocated for a long time by

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renowned orthopaedic leaders such as Watson-Jones and Apley [2, 17]. In 1981, Moulton et al. reported their series of 45 consecutive patients with femoral shaft fractures treated by straight longitudinal traction, supplemented by functional bracing at around 6 weeks [14]. All fractures healed, one with a varus malunion. The average length of stay (LOS) was 8 weeks, and at 6 months, the average knee flexion was 127°. In 1953, George Perkins, making “no apology for questioning orthodoxy,” introduced his technique of starting a very early active range of motion of the knee for adults in tibial traction for femoral shaft fractures [18]. He believed the push–pull action of active muscular contractions on fracture fragments was beneficial to the inflammatory process, and stimulated osteogenesis [19]. We know now this to be largely true, and the principle is even applied in modern internal fixation techniques such as elastic or flexible nailing, and less-invasive surgical stabilisation (LISS) procedures. This principle has also been applied in developing countries, where traction is very often the only possible treatment for femur fractures [11]. May and Neufeld reported good results with their use of a single rope suspension dynamic traction method [13]. Gates modified and adapted this technique to fit the needs and materials available in developing countries [9]. The patient is put in a hinged cast brace within a week of admission, and discharged in his brace after traction is discontinued. In his series, only 1 out of 110 Dominican patients failed to achieve union. The mean length of hospital stay was 26 days, and time to cast brace removal averaged 12 weeks. One patient had a “serious” malunion and 8 (7.3%) healed with a shortening greater than 2.5 cm.

The Perkins technique is even simpler. It does not require a hinged cast brace or an overhead Balkan-type frame. A Steinmann pin is inserted under local anaesthesia just below the tibial tubercle when the patient is admitted, or after surgical irrigation and debridement in the operating room if the fracture is open. Straight traction with an initial weight of 7 or 8 kg is applied, with the foot of the bed elevated on wooden blocks. X-rays in traction are taken 2 or 3 days later, and the weight adjusted as necessary so that there is no distraction, and overriding of no more than 2 cm. A posterior bump may be used for posterior angulation greater than 10–15°. The pin sites are covered and cleaned daily with betadine. Usually, within 3 or 4 days from admission and almost always before the 7th day, active range of motion exercises of the knee are started: the distal half of the bed is broken to 90° or removed, and the patient is encouraged to sit while a therapist cups the affected heel to support the leg. Then, with the weight still pulling, gentle active flexion and extension is started. Pain medication may be necessary for the first few days, but pain levels become tolerable with surprising

rapidity. The flexion/extension exercise regimen is performed for half an hour, twice a day. Usually within a week the patient can sit upright, and can use his opposite, healthy leg to support the affected one during the exercises. After another couple of weeks support is unnecessary. The patient is encouraged to exercise as tolerated. At this point, active flexion of the knee usually reaches 90° (Figs. 1, 2). The hip musculature can be further exercised with the patient standing upright on his opposite limb (Fig. 3). At 6 weeks, clinical healing is assessed by palpation of the callus, feeling for motion at the fracture site, and determining if the patient is capable of straight leg raising. X-rays are taken. If clinical and/or radiological healing is not satisfactory, traction is re-applied, and the same evaluation is repeated every 2 weeks. If healing appears satisfactory, traction is discontinued, and mobilisation is started. A cast or preferably a hinged cast brace may be used, if available, for added protection. Usually, in the otherwise healthy, young, and compliant patient, protected ambulation with crutches and toe-touch weight-bearing is started the next day. When comfortable and safe with ambulation, the patient is discharged with instructions to keep using his crutches until he comes back for clinical and radiological follow-up 6 weeks later.

Reports on the use of the Perkins technique come mostly from developing countries. The results are summarised in Table 1. In 1962, Procter reported his series of 41 patients in South Africa [20]. All were of Zulu origin, and all had achieved clinical union at 6 weeks. The average time for full knee motion was 10 weeks. Complications included 6 patients (15%) with a pin tract infection and 2 (5%) re-fractures. A few years later, Usdin followed up with his own series of 58 patients [21].

Fig. 1 Active Perkins exercises in extension

Fig. 2 Active Perkins exercises in flexion

Average LOS was 7 weeks. There were 6 (10.4%) delayed or non-unions requiring surgical treatment. There were 5 (8.6%) pin tract infections and 2 cases of residual knee stiffness, both in supracondylar fractures. Bewes published his series of 15 patients from Tanzania in 1974 [3]. They had a 100% union rate at 12 weeks, and all had at least 75% of knee flexion at the time. He commented that, to be successful, the Perkins technique requires “enthusiastic persistence” from both patient and surgeon. In 1977, Pearson reported on a series of 100 Nigerian patients treated over an 18-year period with either skin (89) or skeletal (11) traction [16]. Mean time to clinical consolidation was 6 weeks, and to protected ambulation 7 weeks. Two-thirds of his cases were under 20 years of age. Buxton reported in 1981 his series of 50 consecutive patients from the UK [6]. Mean time to clinical and radiological healing was 12 weeks. The 47 (94%) patients who healed all had more than 120 degrees of knee flexion. Eighteen (36%) patients had a pin tract infection, in spite of the routine use of a Denham (centrally threaded) pin. Most recently, Mandrella reported in 2002 a series of 109 fractures treated over an 8-year period in Rwanda [12]. All healed within an average time in traction of 9 weeks. Only 2 required more than 12 weeks of traction and all had at least 80° of knee flexion at the time of discharge.

Fig. 3 Active ROM exercises of hip and knee can also be done in the upright position

The Italian NGO Emergency owns and operates one of the only functional surgical hospitals in Sierra Leone, a small West African country of approximately 6 million people. Located in the capital Freetown, it has about 100 beds, roughly 80 of them for surgical cases and the rest for medical paediatric cases. General and orthopaedic surgical care is provided at no direct costs to patients by local and expatriate surgeons. There are two operating rooms, where both emergency and elective procedures are performed. Since on one hand the risk of surgical infection is significant and on the other hand a prolonged hospital stay is usually not an issue for patients or administration, closed extra-articular fractures, and some intra-articular fractures of the femur are usually treated conservatively. The conversion from other traction methods to the Perkins technique started in August 2003. It has since been systematically used for all closed or open femoral shaft fractures, from the subtrochanteric to the supracondylar area. The purpose of this retrospective study was to analyse the results of this method in this particular environment, comparing with what was done

Table 1 Comparison of reported Perkins series. *LOS* length of stay, *ROM* range of movement

	[20]	[21]	[3]	[16]	[6]	[12]	Current study
No. of patients	41	58	15	100	50	109	53
Mean LOS (weeks)	12	7		7			7.5
Mean time to healing (weeks)	6	6	12	6	12	9	6.5
Non-union	0	6 (10.4%)	0	0	3 (6%)	0	4 (7.4%)
Malunion	0		0		2 (4%)		5 (9.3%)
>2.5 cm short	0				3 (6%)		3 (5.5%)
Re-fracture	2 (5%)	2 (3.5%)			4 (8%)	5 (4.5%)	2 (3.7%)
Pin tract infection	6 (15%)	5 (8.6%)			18 (36%)		23 (42.6%)
Knee ROM (degrees)	All full at 10 weeks	2 stiff	All >75		All >120	All >80	23 full 11 good ^a

^a Knee ROM data was available for 34 out of 54 patients (64.2%) at last follow-up

before, and to identify problems that could be prevented and outcomes that could be improved.

Materials and methods

Given the local constraints of accessibility and costs, a minimum of 3 months' follow-up after discharge, with X-rays, was thought adequate. All admission log books from the Emergency Department, the ICU, and all wards were cross-referenced with the Operating Room and physiotherapy logs to identify all adult femoral fractures presenting during the period from August 2003 to September 2005 (25 months). Patients below the age of 15 or for whom X-rays showed an open physis, were excluded. Fractures that were more than 2 weeks old, had an intra-articular component proximally or distally, or appeared pathological (tumor or osteomyelitis) were also excluded. During that period 91 patients were identified. Charts or X-rays were inadequate in 12 cases. Of the remaining 79 cases, 26 did not meet the minimum 3-month follow-up requirement, leaving 53 patients with 54 fractures.

Before the use of the Perkins method, femur fractures were treated either with straight longitudinal traction or traction with a Bohler-Braun frame. Appropriate record keeping started mid-2002, so records of patients admitted with femoral shaft fractures between August 2002 and August 2003 (12 months) were reviewed. Forty-eight patients with 49 fractures met the inclusion/exclusion criteria, but only 23 patients (48%) had a minimum of 3 months of recorded follow-up.

Consolidation was assessed clinically by looking for motion at the fracture site, the ability to do straight leg raising without deformity or pain, and later on, pain with weight-bearing. All patients in the Perkins group had X-rays taken before discharge and at return follow-ups. A non-union was diagnosed if there was still motion at the fracture at last follow-up. Healing with more than 10° of varus or valgus in the frontal plane, or 15° of anterior/

posterior angulation in the sagittal plane was considered a malunion. A pin tract was considered infected if there was purulent discharge, loosening or ring sequestrum on X-rays, but not if there were only local inflammatory signs, even if they resolved with antibiotics.

Statistical analysis was done with the Student's *t* test comparing means of large samples, using the Small Stata 8 software, with statistical significance at a *p* value <0.05.

Results

The average age of the 53 patients treated with Perkins traction was 34.2 years (range 16–71). There were 43 males and 10 females. Twenty-eight fractures were on the left side and 26 on the right. The mid-shaft was involved in 36 cases (66.6%), the proximal third in 13 (24%), and the distal third in 5 (9.3%). The fracture was comminuted (>2 fragments) in 41 cases (76%). Almost two-thirds of the fractures were due to road traffic accidents, most of the others due to falls. Only 4 were open (7.6%), including one gun shot wound. Twenty-five patients (47.2%) also had significant associated injuries, including 6 head injuries, 4 chest injuries, 3 abdominal injuries, 4 pelvic fractures, 5 ipsilateral tibia–fibula fractures, and 3 contralateral tibia–fibula fractures. The mean length of stay was 52.1 days (range 25–108) and time in traction averaged 45.0 days (range 23–66). At the time of discharge, 34 patients (64.2%) were using crutches or a walker for protected ambulation, 10 were in a plaster of Paris cast (18.9%), 5 were in a hinged cast brace (9.5%), and 4 were using a wheelchair (7.6%).

Clinical and radiological follow-up averaged 4.6 months (range 3–9). At last follow-up, 50 fractures had healed (92.6%), 5 of them with a malunion (9.3%). There were 4 non-unions (7.4%) and 3 patients had a shortening greater than 2.5 cm (5.5%). Knee range of motion was recorded in 34 patients (64.2%) and reported as full in 23 and good in 11. Two patients had a re-fracture (3.7%), one 3 days and one 2 weeks after mobilisation, both of which healed

uneventfully after resuming Perkins traction. More alarming was that 23 patients (42.6%) had a pin tract infection at an average of 29 days of traction (range 6–44). Seventeen patients healed with pin removal and antibiotics, 4 patients had a second pin reinserted distally, and 2 required surgical debridement to remove a sequestrum.

The 48 patients with 49 fractures in the pre-Perkins group showed no difference from the Perkins group with regard to mean age (35.0 years), length of stay (55.9 days), duration of traction (43.8 days), side or site of fracture, or associated injuries. There were differences in sex distribution (24 males:24 females) and number of open fractures (6 or 12.3%). There were 18 pin tract infections (36.2%) and 3 (6.3%) recorded pressure sores (none in the Perkins group). Of the 23 patients in the pre-Perkins group with a 3-month minimum follow-up (mean 4.5 months), 5 (21.8%) had a non-union at their last visit. This difference from the Perkins group is statistically significant ($p < 0.01$).

Discussion

Conservative management of adult femoral shaft fractures is now used almost exclusively in environments where resources are significantly limited. This will remain the case until human, technical, and infrastructural capacity to carry out surgical fixation in a safe, reliable, and sustainable fashion is available. Union rates are consistently reported as being above 90% [2, 6, 9, 12, 20, 21]. Prolonged hospital stay and rehabilitation, with their associated direct and indirect costs, are usually not as much an issue as in richer countries. In the transitional environments of developing economies, the risks and benefits of conservative treatment still need to be weighed against those of surgical fixation by overly enthusiastic, but inadequately trained hands working in less than favourable conditions.

A retrospective study such as this one is fraught with limitations and biases: quality of records and data, a large number of patients lost to follow-up, historical control group, to name only a few. The purported benefits of Perkins traction over other methods is that healing rates are the same or better while causing very little if any residual knee stiffness, thus reducing the overall recovery time [18, 19]. The 7.4% non-union rate in the Perkins group appears to compare favorably with the 21.8% of the pre-Perkins group, and is in line with other reported series [6, 21]. The many potential biases and confounders prevent drawing any meaningful conclusions. Without knowing the outcomes at 6 and 12 months, the true rate of non-union remains unknown. The data on knee motion, although apparently showing good results in the Perkins group, are too poor to lend themselves to critical analysis. Complications such as malunion, excessive shortening, and re-fractures are more

or less in line with data reported from other Perkins series [6, 12, 20, 21]. However, the pin tract infection rate of 41.7% for all Perkins procedures is much higher than those in other series: 8.6% [21], 15% [20], and 36% [6]. This is likely mostly due to technical considerations: re-using many times the same smooth, blunt Steinmann pins, generally inserted with a carpenter drill of dubious sterility, and often without the corresponding traction bow, which leads to frequent re-adjustments of the traction apparatus. Host factors such as chronic undernourishment or decreased immunity may also play a role. Since the pre-Perkins group had a similar rate of infection (37.5%), the Perkins exercise regimen itself is probably not to blame. A more rigorously sterile technique, the systematic use of a hand drill to avoid thermal necrosis, and the use of sharp, centrally threaded pins (Denham) should help to decrease this complication to acceptable levels.

This hospital treats approximately 50 adult femoral shaft fractures a year, and this number will increase as road traffic accidents are on the rise, even in this very poor country. Conservative management will remain the treatment of choice for the foreseeable future, with surgical treatment reserved for some intra-articular fractures, established non-unions or unacceptable malunions. Technical improvements may decrease significantly pin tract infections, at very little cost. Since other complications are in line with other published reports, and healing in a good position can be achieved approximately 85% of the time, with anecdotally better knee motion than other methods, the Perkins method seems a safe and valuable treatment option for this particular environment.

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