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Use of the Ilizarov technique to improve limb function following hemipelvectomy

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Aims: Limb salvage surgery combined with tumour resection has become established in the management of pelvic tumours. However, subsequent reconstructive options for maintaineance of quality of life lead to varied outcomes. We present a hitherto undescribed use of the Ilizarov technique as a second stage adjunct, for the optimisation of function, after first stage tumour resection and arthrodesis.

Methods: We describe the surgical technique used to address leg length discrepancy and abductor dysfunction following internal hemipelvectomy with ischifemoral arthrodesis. Distal femoral and distal tibial lengthening using circular frames, with a valgus subtrochanteric femoral osteotomy, enabled a rapid correction of both anomalies. Controlled varus correction at the distal femoral osteotomy site was performed to obtain a horizontal joint line at the knee.

Conclusion: The Ilizarov technique is suitable for selected patients with tumour free survival following the initial resection. Our experience indicates that it is a good alternative to a mammoth one stage internal hemipelvectomy with reconstruction. The latter is often attempted even though there is a high risk of local recurrence and distant metastasis.
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Key words: pelvic tumours; hemipelvectomy; arthrodesis; Ilizarov.

INTRODUCTION

Pelvic tumours have previously been treated with standard hemipelvectomy, i.e., hind-quarter amputation.[1–3] However, currently internal hemipelvectomy with limb preservation is the favoured treatment option.[4–9] Steel,[10] in 1978, first described hemipelvectomy with limb preservation. The term 'internal hemipelvectomy' was coined by Burri *et al.*[11] and Eilber *et al.*[12] Enneking[6,13] classified the procedure into different types based on the regions resected. In a review of 32 patients treated with internal hemipelvectomy for pelvic tumors,[4] a survival rate of 45% at 10 years was reported, when resection was done for cure. The same study reported 34% patients ambulated without aids, 59% ambulated with crutches and 7% remained wheel chair bound. Though various reconstructive options[11,14–26] have been used to rehabilitate patients of internal hemipelvectomy, they are associated with significant complications and mixed functional results. We report the use of an Ilizarov frame to treat limb length discrepancy and improve limb function after internal hemipelvectomy. A medline literature review did not reveal any publications to date of a similar nature.

MATERIALS AND METHODS

A 23-year-old, male patient presented with a 6 cm limb length discrepancy affecting his left leg. He had undergone internal hemipelvectomy with ischiofemoral arthrodesis at the age of seven, at Bologna, Italy. This had been performed for fibrosarcoma affecting his left innominate bone. The patient had received adjuvant chemotherapy but no preoperative or postoperative radiotherapy. He had been disease free following the original resection.

At presentation, the patient was neurologically intact and mobilising using a shoe-lift, without any other walking aids, though with a pronounced trendelenberg gait. There was marked compensatory convexity of the lumbar spine towards the affected side. Trendelenberg test was positive even after a monopodalic support was used to correct the shortening (Fig. 1). Standing anteroposterior radiographs were performed with a block beneath the patient's left foot to eliminate his limb length discrepancy (Figs 2 and 6). These demonstrated a

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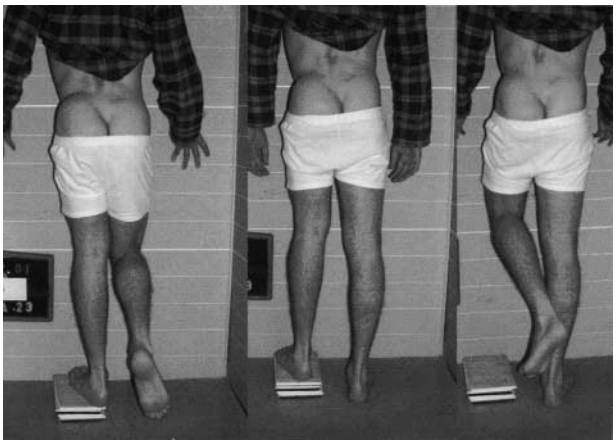

Figure 1 Pre-operative leg length discrepancy and Trendelenberg test.

Figure 2 Pre-operative X-ray of the pelvis.

twenty degree angulation of the symphysis pubis joint line with respect to the sagittal plane.

Pre-operative plan

A pre-operative plan was formulated to perform distal femoral and distal tibial lengthening. The use of two sites for simultaneous distraction was planned to allow a reduction of the treatment time. To address the positive Trendelenberg test, a 40° valgus subtrochanteric femoral osteotomy was to be performed acutely. This would over-correct the 20° angulation at the symphysis pubis joint and re-tension the residual muscle mass at the site of the internal hemipelvectomy. After lengthening, gradual varus correction would be performed, at the distal femoral osteotomy, to make the joint line of the knee horizontal. It has been the experience of the senior author (M.A.C.) that due to adaptation in the soft tissues during the lengthening phase, the total angular varus correction required at the distal femoral osteotomy is less than the 40° of valgus performed at the proximal femoral osteotomy. Close clinical and radiographic follow up is vital to determine the amount of varus correction that is ultimately required.

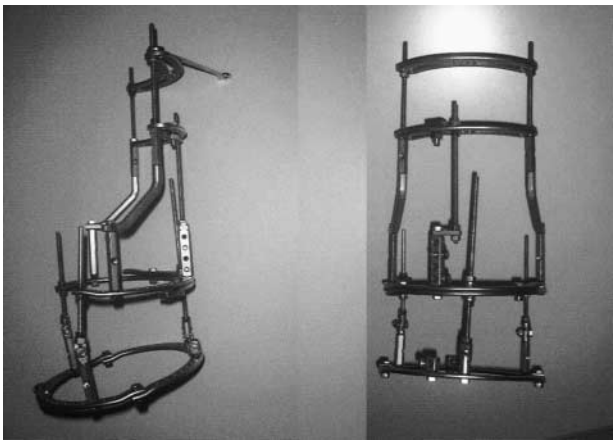

Figure 3 Pre-assembly of the femoral frame (A–P and Lateral).

Surgical technique

Pre-assembly of the femoral and tibial Ilizarov frames was done,[27] based on the dimensions of the limb and the radiographs. For the femoral frame, two arches were used proximal and distal to the site of the planned subtrochanteric osteotomy (Fig. 3). A 5/8 ring and a full ring were positioned proximal and distal to the planned distal femoral osteotomy site. The 5/8 ring and the full ring were connected with two 'hinges', affixed in an anteromedial and posteromedial position on the frame. A 'motor' was also attached between these rings in the true lateral position, i.e., in the same coronal plane as the anatomical axis of the femur. Preassembly of the tibial frame was also done using three rings.

With the patient supine, three reference wires were inserted percutaneously in the proximal femur as demonstrated (Fig. 4). The first wire was inserted perpendicular to the anatomical axis of the femur at the level of the planned subtrochanteric osteotomy. The second wire was inserted proximal to the first and at an angle of forty degrees to it, this being the degree of valgus required at the osteotomy site. The third wire was inserted parallel to the second wire and proximal to it to check that adequate half-pin fixation could be achieved in the bone segment proximal to the subtrochanteric osteotomy. This also acted as a guide for the angle of half-pin insertion. An intra-operative radiograph was performed to ensure that the wire positions were satisfactory. The Ilizarov frames were applied to the femur and the tibia of the affected side, using the hybrid advanced technique.[27] A subtrochanteric femoral osteotomy was performed parallel to the first reference wire and just proximal to it. At this site an acute valgus angulation of 40° was then performed by making the first and second reference wires parallel. The lateral edge of

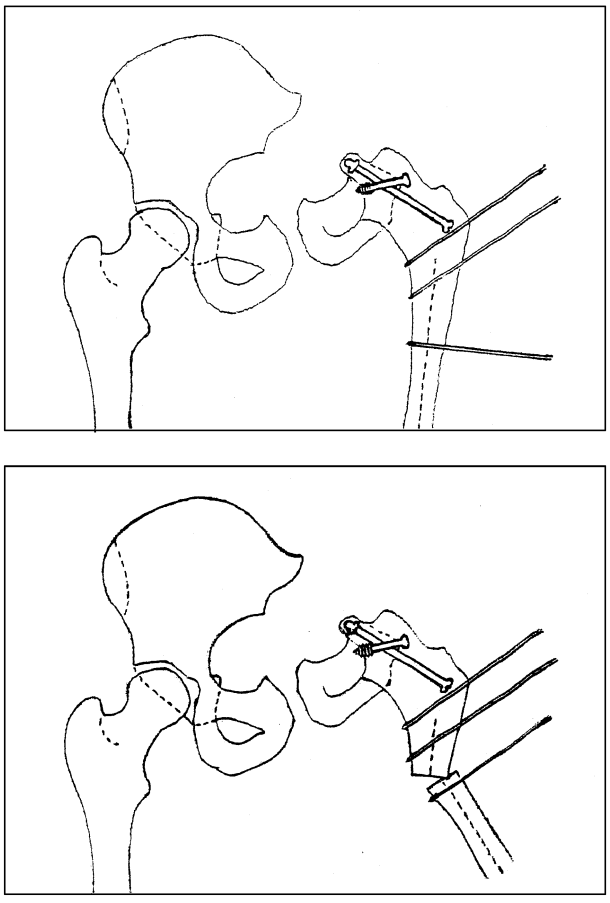

Figure 4 The pre-operative plan of the proximal femoral osteotomy.

the proximal femoral segment was positioned in the medullary canal of the distal femur, to provide a more stable construct on loading (Figs 4 and 5). Distal femoral, distal tibial and fibular osteotomies were also performed at the same time.

Post-operative management

Starting on the day 8 of frame application, lengthening was carried out at a rate of 0.75 mm a day at each of the distal femoral and distal tibial osteotomies, i.e., a total of 1.5 mm a day in the lower limb. The distraction was halted after obtaining 3.5 cm of lengthening at the distal femoral osteotomy and 2.5 cm of lengthening at the distal tibial osteotomy. At the end of femoral lengthening, gradual varus correction was performed at the distal femoral osteotomy, to obtain a horizontal knee joint with appropriate alignment of the mechanical axis. This was confirmed both clinically and radiographically (Fig. 6).

Partial weight-bearing mobilisation and physiotherapy had been initiated postoperatively. This was continued during the entire period of treatment to allow consolidation of the new bone formation at the three sites. Radiographic and clinical follow up demonstrated good corticalisation at 5 months from frame application.

Figure 5 Immediate post-operative X-ray of the proximal femoral osteotomy.

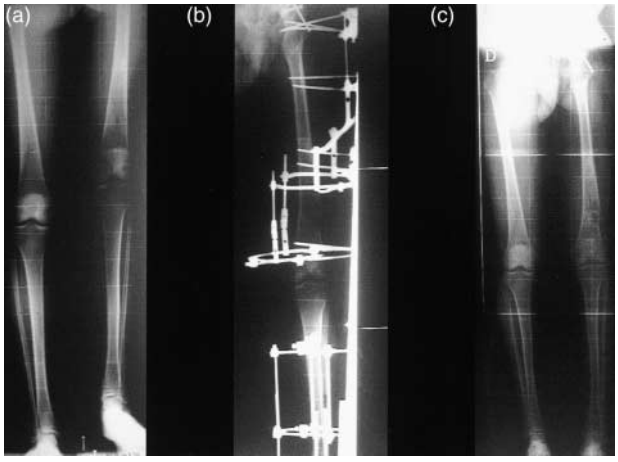

Figure 6 (a) Pre-operative scanogram of the lower limbs. (b) Scanogram of the lower limbs following lengthening. (c) Scanogram of the lower limbs following frame removal.

Dynamisation of the three sites was then started. A standard technique was used for this step. The patient loosened the nuts holding one of the threaded rods bridging an active focus, using a spanner and then retightened the nuts by hand only. The following day, the same procedure was performed for the threaded rod adjacent to the first one. This was continued sequentially on a daily basis, in a clockwise or anticlockwise direction, for each of the threaded rods bridging an active focus. This process was carried out at each of the three active foci for a period of 30 days. It enabled gradual load transfer from the frame to the active foci and eliminated stress shielding at these sites.

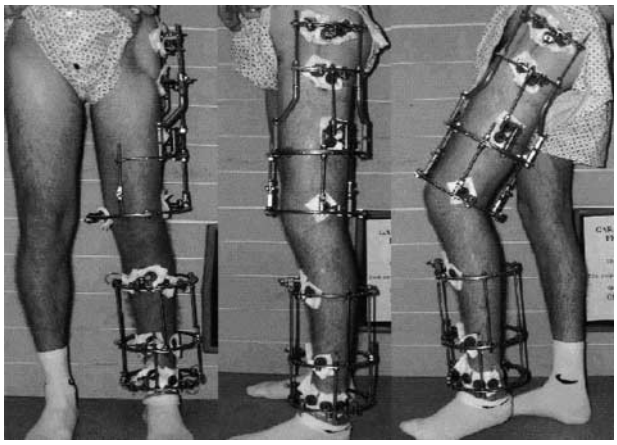

Figure 7 Clinical picture prior to removal of Ilizarov frames.

Figure 8 Clinical picture at follow-up with a negative Trendelenberg test.

The patient did not develop any complications (e.g., pin-site infections, loss of fixation or wire breakage). At 6 months from frame application, X-rays revealed good consolidation and maturation of the new bone formation. Clinical examination (Fig. 7) demonstrated that the patient could fully weight bear without pain and had good hip and knee flexion. There was no pain on stressing the sites of new bone formation. The femoral frame was hence removed followed by the tibial one at an interval of two weeks (Fig. 6). A patellar tendon bearing cast was applied to the leg for a period of 1 month, following which the patient was allowed to mobilise free of plaster.

Though rapid bone lengthening had been performed at two osteotomy sites, adaptive lengthening of the soft tissues is always a slower process. This limitation was overcome by an intensive physiotherapy and home-exercise regime, initiated from the time of frame application. The initial tightness of the ankle plantar flexors was overcome gradually by the above non-operative means and no surgical releases were required to address soft tissue contractures. There was no evidence of muscle paralysis or peroneal nerve injury at follow-up. At 3 months following the removal of plaster, the patient had regained a range of abduction from 10 to 45° and a range of flexion from 10 to 30°, due to compensatory mobility of the symphysis pubis and sacro-iliac joints. Trendelenberg test was negative (Fig. 8) and a full range of movement of the knee and ankle joints was present. The patient continued to mobilise unaided with a satisfactory gait pattern.

DISCUSSION

Several options for pelvic reconstruction after internal hemipelvectomy have been reported using prostheses, allografts, autoclaved grafts and free vascularised fibular grafts.[11,14–26] Complications including implant loosening, dislocation and deep infection accompany the use of hip prostheses with massive allografts. This can result in a flail hip if removal of the prosthesis is necessitated.[15,18] One-stage reconstruction with free vascularised fibular grafts often with concomitant spinal instrumentation, external or internal fixation [21,25] is a complex procedure requiring meticulous technique and long operating times. The use of an Ilizarov frame, as outlined above, is a useful addition to the armamentarium of the orthopaedic surgeon in dealing with the vexing problem of functional rehabilitation following internal hemipelvectomy. It allows use of a conventional arthrodesis for limb salvage, with second stage limb lengthening with or without valgus osteotomy of the proximal femur. This optimises long term functional outcome and it may be the procedure of choice in skeletally immature patients, in whom hip arthroplasty is not such an attractive treatment option.

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