■ CHILDREN'S ORTHOPAEDICS

Proximal femoral resection without post-operative traction for the painful dislocated hip in young patients with cerebral palsy

A REVIEW OF 79 CASES

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Proximal femoral resection (PFR) is a proven pain-relieving procedure for the management of patients with severe cerebral palsy and a painful displaced hip. Previous authors have recommended post-operative traction or immobilisation to prevent a recurrence of pain due to proximal migration of the femoral stump. We present a series of 79 PFRs in 63 patients, age 14.7 years (10 to 26; 35 male, 28 female), none of whom had post-operative traction or immobilisation.

A total of 71 hips (89.6%) were reported to be pain free or to have mild pain following surgery. Four children underwent further resection for persistent pain; of these, three had successful resolution of pain and one had no benefit. A total of 16 hips (20.2%) showed radiographic evidence of heterotopic ossification, all of which had formed within one year of surgery. Four patients had a wound infection, one of which needed debridement; all recovered fully. A total of 59 patients (94%) reported improvements in seating and hygiene.

The results are as good as or better than the historical results of using traction or immobilisation. We recommend that following PFR, children can be managed without traction or immobilisation, and can be discharged earlier and with fewer complications. However, care should be taken with severely dystonic patients, in whom more extensive femoral resection should be considered in combination with management of the increased tone.

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Dysplasia of the hip is a frequent complication of severe cerebral palsy, affecting up to 90% of children who are Gross Motor Functional Classification System (GMFCS)[1] level V. If not treated early, it may cause pain and limited movement, affecting sitting, hygiene and quality of life.[2,3] If reconstruction and other methods of salvage are not possible, suitable or available the established painful displaced hip can be treated by excision of the proximal femur. The aim of this treatment is to give the patient a painless, mobile hip that enables a comfortable sitting position in a wheelchair, relieves pressure areas and allows easy access for perineal hygiene.[4,5] Proximal femoral resection (PFR) has been described in the literature and is considered a good treatment for children with pain.[2-4,6-9]

In 1978, Castle and Schneider[3] were among the first to describe the technique, and variations on their method have been reported subsequently.[3,6-10] Unlike a Girdlestone resection arthroplasty, for a PFR the proximal femur must be resected distal to the lesser trochanter.[4,10] The main complications of this procedure are proximal migration of the femur causing femoropelvic impingement; regrowth of the bone; and heterotopic ossification.[2,3,6,9,11] Extra-periosteal resection is recommended to prevent regrowth and heterotopic ossification. Post-operative traction has been recommended to prevent proximal migration. The recommended duration of traction varies from two to 12.8 weeks.[6,7] Various methods of interpositional grafting have been described,[3,7,8,10] and alternative methods of immobilisation involving, for instance, external fixators and spica casts[7,9,10] have also been described. The complications of these methods include skin breakdown and decubitus ulcers, pin-site infections, stiffness, and respiratory and urinary tract infections. However, no authors have reported the outcome of PFR without post-operative traction or any form of immobilisation. We present the results of PFR without the use of post-operative traction or immobilisation.

Patients and Methods

A total of 63 children and young adults who had undergone 79 PFRs by three surgeons (JMHP, MG, FNT) between 1996 and 2011

were identified at the Evelina London Children's Hospital (ELCH) and The Royal London Hospital (RLH), London, United Kingdom. All had severe subluxation or dislocation of the hip, intractable pain, and difficulty with sitting and perineal hygiene. All hips had a Reimer's migration index (RMI) > 50%[12,13] and were not amenable to reconstruction, either because of deformities of the femoral head and/or acetabulum or because the child was medically unfit for major surgery. No post-operative traction was used in those who underwent surgical treatment. During the same period approximately 400 hip reconstructions were performed, in the form of femoral and/or acetabular osteotomies, and around 100 hips were treated non-operatively.

The study had ethical approval and the notes of the patients were reviewed pre-, peri- and post-operatively for demographic details, medical and surgical information, and for any complications that had been documented. Hard copies of the notes of ten patients were unavailable, including five who had died of unrelated causes and five for unknown reasons. However, most of the relevant information was available on computer, and their results were included. During routine follow-up, the primary care-giver was questioned along with the patient, verbal consent was taken, and the data were anonymised. Pain was categorised in accordance with the care-giver's response as none, mild, moderate, severe, constant or no different.

The mean age of the patients at surgery was 14.7 years (10 to 26). There were 35 males and 28 females. The mean follow-up was 5.2 years (1 to 14). All patients except one were GMFCS level V; the exception was GMFCS IV. A total of 16 had undergone previous reconstructive surgery to the affected hip in the form of femoral and/or acetabular osteotomies. Only one child had assisted standing ability pre-operatively. The primary indication for surgery was severe, persistent pain.

Because of the nature of cerebral palsy these patients were a heterogeneous group, for example with respect to medication, medical comorbidities, previous surgery and social/domestic circumstances. No patient was in an institution or care home, and as such, the main care-giver of each was a biological, adoptive or foster parent.

Length of stay. Information documenting the length of stay was available for a subgroup of 34 of the 43 patients from ELCH. The mean length of stay was 4.1 days (two to seven).

The primary outcome was the need for revision surgery or lack of pain relief. Secondary outcomes included the assessment of pain, seating and hygiene. Clinical assessments of pain and crepitus on movement were documented as evidence of proximal femoral impingement.

Radiographs were assessed independently by two orthopaedic trainees (JD) for the presence and degree of heterotopic ossification, graded according to McCarthy et al.[10] As there was complete agreement between the senior authors and the trainees, inter-observer reliability was deemed excellent and therefore not formally assessed. The level of the lesser trochanter on the pre-operative radiograph was recorded as below, at the level of or above the acetabulum. This was done to try to establish whether the height of the dislocation correlated with the post-operative level of pain, and whether the child subsequently needed revision surgery.

Operative technique. The procedure was carried out as described by Castle and Schneider,[4] the only exception being the lack of post-operative traction. The femur was exposed by extra-periosteal dissection, detachment of muscles and circumferential division of the capsule. If necessary, the ligamentum teres was divided to deliver the femur, which was divided at least 2 cm distal to the lesser trochanter. Secure soft-tissue cover of the acetabulum was achieved by repair of the capsule and/or abductors, and of the proximal femoral stump by the vastus muscles. All patients were expected to be discharged on the fourth post-operative day, although the carer was advised that admission might be up to a week. All carers were advised to return the patient to normal activities as soon as comfort allowed, and to use analgesics as required. Radiographs were taken at routine follow-up appointments.

A group of 20 patients under the care of one surgeon (JMHP) received indomethacin post-operatively (0.5 mg/kg for ten days, given with gastrointestinal protection) as prophylaxis against heterotopic ossification (HO). We have shown elsewhere that this had no effect on the outcome.[14]

Post-operative analgesia was by epidural fentanyl and/or bupivacaine for 24 to 36 hours, and subsequently by oral analgesics, including morphine, codeine and paracetamol, as needed. If an epidural was not possible or desirable, a nurse-controlled morphine infusion was used. Baclofen and/or diazepam were added for control of tone and spasm according to need.

Results

Further resection. Four patients underwent further resection of the femur. One of these was undertaken because it was thought that insufficient bone had been resected at the initial surgery; this child was reported to be in moderate pain from the hip all of the time, and further resection was felt justified. The further surgery, however, made no difference to the pain and the cause remained unknown. Two children were severely dystonic, with marked scoliosis and a low body mass index, and had wound problems from the prominent end of the resected femur. They had a good result from further resection. The fourth patient who had a further resection also had type II HO and made an excellent recovery, gaining pain relief immediately.

Heterotopic ossification *versus* outcome . A total of 11 hips had McCarthy type 1 HO, four had type II and one had type III.[10] Seven children did not have radiographs at follow-up appointments but were all pain free, and none had crepitus or clinical signs of impingement. One child with type I HO was advised to have further resection for pain relief, but was not sufficiently fit for surgery and the pain subsequently resolved. Two children with type II HO were

recommended to undergo further surgery. The parents of one refused further intervention, and the other child made a good recovery following revision PFR. The other children with HO, including the child with type III, were all pain free. All HO had formed within a year of initial resection.

Pain relief. It was apparent which hip was or was not painful even in the bilateral cases. A total of 71 hips (89.6%) were reported by the carers to be pain free or only to have occasional discomfort following surgery. A total of six (7.6%) caused moderate pain and in two (2.5%) the pain had not improved. In two children it took two years for the pain to settle down, whereas in all the others it settled – if it was going to – within six months post-operatively.

One child, who was reported by the carer to be in constant severe pain with no improvement post-operatively, was seen on several occasions in clinic and thought to be comfortable, allowing good movement of the leg and easy access for hygiene. There was no crepitus or sign of impingement. The patient did not have impingement from the proximal femur clinically or radiographically.

Hygiene, seating and transfers. A total of 59 children (91%) had improvements in access for perineal hygiene and transfers. One needed a suprapubic catheter owing to problems in transferring post-operatively. Most children required adjustments to seating to allow for the shortened thigh. The parents of the child with some pre-operative standing ability, despite extensive pre-operative counselling, were disappointed that she lost this ability following PFR.

Pre-operative level of dislocation *versus* outcome. In 34 hips (43.6%) the lesser trochanter was below the level of the acetabulum pre-operatively, in 29 (37.2%) it was in the lower half of the acetabulum, in 11 (14.1%) in the upper half, and in 4 (5.1%) it was above the level of the acetabulum. None of the hips with a high dislocation pre-operatively had pain at follow-up. However, the parent of one of these children complained about the floppiness of the limb. Both dystonic children needing further resection had a low dislocation. The radiographs of two children complaining of moderate pain post-operatively showed the lesser trochanter to be at the level of the lower half of the acetabulum. The other children complaining of pain, or for whom revision surgery was considered or performed, had a low dislocation.

Complications. Wound infection occurred in four hips, three of which responded well to oral antibiotics. One underwent debridement, following which the wound healed with a satisfactory outcome. One very thin child had bilateral ischial pressure sores when seen three years after bilateral PFRs; these were successfully treated conservatively.

Discussion

PFR is a good pain-relieving treatment for the chronically dislocated painful hip in patients with severe cerebral palsy. Perineal hygiene and dressing are easier for carers and more comfortable for the children, who are able to sit in a wheelchair for longer periods. Although post-operative traction or immobilisation have previously been recommended, we aimed to minimise the length of hospital stay and the risks of nosocomial infection, respiratory infection and skin complications, such as decubitus ulcers, by early mobilisation.[2-4,6,8-10] Pain relief is the ultimate goal, and thus in two children (3.2%) in this study the treatment failed, as they had persistent pain. The reason for the pain remains unknown. We do not consider the development of HO to represent a failure of treatment.

The absence of post-operative immobilisation did not adversely affect the outcome. These patients were discharged from hospital within about four days and were handled normally straight away. The rate of further resection of 6.5% compares favourably with the studies where traction or distraction was used (0% to 25%) (Table I).[15,16] Several authors have not recorded whether any children needed further resection when discussing HO or proximal migration.[8,9] Some of those that do are shown in Table I.

HO is a well-documented complication of PFR; in our study its incidence and that of proximal migration was low. The operative method described by Castle and Schneider,[4] and the variations, which were subsequently reported using spica casts, external fixators and both skin and skeletal traction, aimed to consolidate the scar tissue around the acetabulum and proximal femur to prevent HO and proximal migration.[6,8-10,17] Some authors believe that the rate of formation of HO increases when there is more movement at the site of a resection or fracture,[10] and Muthusamy et al[9] reported more HO when children who undergo PFR are fitted with hinged external fixators than when spica casts are used post-operatively. They suggested that it was the increased movement that stimulates ossification. However, in patients with a head injury prolonged immobilisation is more of a risk factor, as is limb spasticity,[18,19] and passive physiotherapy actually appears to prevent the formation of HO.[19,20] This implies that allowing movement at the site of resection is preferable to immobilisation and distraction for the prevention of HO. Our results support this, showing low levels of HO when the child is allowed immediate mobilisation.

We also suggest that the presence of HO is not necessarily a bad prognostic sign, as persistent pain does not seem to be attributable to the degree or presence of HO. The patient with the most severe HO in our study, McCarthy type III, was asymptomatic. Although one goal of surgery is a mobile hip, and the avoidance of HO remains important, a possible explanation is that the hip had stiffened early on in a good position, allowing easy hygiene and sitting; and that the lack of movement meant no pain. McCarthy et al[10] also noted that their patient with the most severe HO had a good outcome. Other authors also report that none of their patients with HO needed further resection.[9,10,17,21,22] We postulate that the appearance of a spike of bone is due to periosteal new bone formation or endosteal overgrowth, similar to that seen after amputation surgery, and is not HO (Fig. 1). The spike of McCarthy type 2 HO points laterally, but was more frequently seen to point medially in this

Table I. The types of traction, complications and rates of revision in other papers on proximal femoral resection

Author	No. PFRs	Distraction method	Length of stay (wks)	Traction complications	% HO	% revised	Reason for revision/ lack of pain relief
This study	79	None	N/A	N/A	20.2	6.5	1 HO, 1 insufficient resection, 2 dystonic proximal migration
Castle and Schneider[4]	14	Skin traction	Until wound healing	–	–	–	–
Ackerley et al[15]	12	6 skeletal, 1 spica	4 to 6	5 pin site problems, 1 spica pressure sore*	100	0	N/A
Widman[2]	18	6 skeletal, 9 skin traction, 2 none	3-6	4 decubitus ulcers, 2 pneumonias	88.9	11.1	2 HO
Baxter[11]	5	Skeletal traction	3-6	1 decubitus ulcer	0	0	N/A
Knaus and Terjesen[7]	34	13 skin traction	2 to 5	0	100	2.9	1 HO (died post-op)
		1 skeletal	–				
		1 spica	4				
		4 abduction plaster	2 to 3				
		1 none	–				
Leet et al[8]	23	11 skin/skeletal, 5 ex-fix	–	2 pin site problems, 1 pneumonia, 3 decubitus ulcers	21.7	–	–
Egerman et al[3]	43	Skeletal and skin traction	2 and 4 (6)	0	51	4.7	1 HO1 proximal migration
Lampropoulos et al[6]	4	Hinged ex-fix	12.8 (mean)	0	100	25	1 proximal migration
Abu-Rajab and Bennet[21]	21	Skeletal traction	3	4 severe reflux	57	4.8	1 proximal migration
McCarthy et al[10]	56	Skeletal traction and daily manual distraction	6	0	73.2	5.4	3 HO
Muthasamy et al[9]	36	16 Hinged ex-fix 20 spica	6-8	1 conversion ex-fix to spica for pin loosening, 1 conversion spica to ex-fix for intractable pain	41.7	–	–
Albinana and Gonzalez-Moran[16]	8	Skeletal traction	3	1 pneumonia, 1 GI bleed	37.5	0	N/A
Yankeum et al[17]	21	Spica	–	–	24	–	–
Sabo et al[22]	8	Skin traction	–	1 UTI, 2 pneumonia, 2 decubitus ulcers	100	25	–
Patients on traction							
Total	303	–		–			–
Means					61.2	7.9	
Range			2 to 12.8		0 to 100	0 to 25	

* Fracture, occurred three months post-operatively. GI, gastrointestinal; UTI, urinary tract infection; HO, heterotopic ossification

study. All spikes were, however, recorded as HO in this paper to conform to our interpretation of the McCarthy grading, and there seemed to be no other way to classify them. It appears to be this endosteal overgrowth that causes the pain that requires revision surgery.

An example of this is shown in Figure 1. Careful extraperiosteal dissection and soft-tissue handling, thorough lavage and the cover of the divided end of the femur and acetabulum, with the vasti and the abductors, respectively, probably limit the formation of HO and endosteal overgrowth. Capping the femoral stump with bone may improve the radiological appearance, although not necessarily the clinical outcome.[3]

We found that the follow-up radiograph is a poor predictor of the need for revision surgery, and we would suggest that they are not necessary. Only children with persistent pain need a radiograph. Bone overgrowth or HO was not in itself an indication for further surgery. Although other forms of salvage procedure are available for the painful dislocated hip in cerebral palsy, PFR is the authors' preferred method, as it seems to give more reliable pain relief. The pain may take some time to settle, and the surgeon should not be premature in resecting further bone. This is especially true of the development of HO, as with time this is likely to be become painless. Most of these children are complex and challenging to care for, so preparing parents

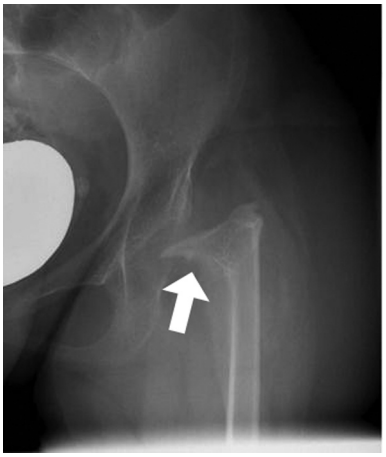

Fig. 1

Radiograph illustrating a spike of bone, probably due to endosteal or periosteal new bone formation, but not heterotopic ossification.

for the inevitable 'floppy limb' and short leg is also important. Other options include extension osteotomy with excision of the femoral head, reported by McHale, Bagg and Nason,[23] which showed good results in a small cohort of children. This procedure has the disadvantage of needing internal fixation, having a reduced post-operative range of movement compared to PFR, and an increased risk of bone-to-bone contact leading to pain. Arthrodesis[24] and arthroplasty[25] have also been described. These are technically difficult and have inferior results to PFR, with complications such as pseudarthrosis and dislocation being common. Various interpositional arthroplasties, such as with humeral implants,[26] have been reported, again with poor results.

We have shown that the rate of revision resection after PFR is not reduced by the use of post-operative traction or immobilisation. In our study only five hips (6.5%) required revision, so it is difficult to draw conclusions about the risk factors for revision. Interestingly, the degree of dislocation of the hip pre-operatively was not a predictor of femoropelvic impingement or proximal migration. We thought that children with higher hip dislocations would be more likely to need revision, as soft-tissue contractures may limit the distalisation of the stump, but this was not the case. It may be, however, that surgeons tend to resect more when the dislocation is higher. This information was not available, but it makes sense to take this precaution. As in all forms of cerebral palsy surgery, severe dystonia may be a contraindication for PFR. These children have unpredictable muscle tone, and spasms may be a challenge post-operatively. The management of tone may be difficult, and consideration should be given to more extensive resection. Surgeons should be aware that further resection may not help if pain is not relieved following PFR, and should consider alternatives such as botulinum toxin injections.[27]

This study has limitations. It was not a randomised controlled trial; data were collected retrospectively, and the outcome was compared with other previously published series. However, PFR has already been shown to be effective for pain relief, and our primary aim was to show that traction is not required post-operatively. Pain relief at follow-up was based on a subjective report from the carers, as at the time few of the children had been assessed using validated scores for pain and quality of life, such as The Caregiver Priorities and Child Health Index of Life with Disabilities questionnaire (CPCHILD).[28] With time, results using these scores will be available. As with all studies involving non-verbalising patients, results relying on caregiver responses must be taken with some caution. The children were from three different consultants in two neighbouring NHS Trusts, but were similar and the surgical techniques were the same; and we are confident that it was appropriate to combine them to increase the number of patients reported.

In summary, we recommend that PFR be performed in cerebral palsy patients with unreconstructable hip displacement, without the use of traction or any other form of immobilisation. We have shown it is highly successful in relieving pain, with minimal complications and need for further surgery.

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