



Internal fixation of a traumatic fracture around a hip resurfacing arthroplasty using the proximal femoral locking compression plate

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We report on a 40-year-old man who sustained a traumatic extracapsular fracture of the proximal femur with a Birmingham Hip Resurfacing *in situ*. It was decided to retain the resurfacing implant and a proximal femoral periarticular locking compression plate (Synthes) was used to stabilise the fracture. The patient regained full range of pain-free movement, and was bearing his full weight on the operated leg by 18 weeks. He had a Harris Hip score of 90. Fractures around hip resurfacing arthroplasties are an emerging problem, and a literature review reveals two distinct modes of presentation i.e. 'atraumatic' and 'traumatic' fractures. We elaborate on these two different fracture patterns, with emphasis on the epidemiology, biomechanical considerations, and management strategies for the 'traumatic' type of periprosthetic fracture.

Keywords : resurfacing arthroplasty ; periprosthetic fracture ; locking plate ; avascular necrosis.

INTRODUCTION

Resurfacing arthroplasty is an accepted option for degenerative hip disease in the younger, healthier, more active adult. The implants used worldwide include the Birmingham Hip Resurfacing (BHR® ; Smith & Nephew), Cormet® (Corin), Conserve® (Wright Medical Technology), Durom® (Zimmer), and ASR® (DePuy) (8). Periprosthetic fractures with contemporary resurfacing arthroplasty designs are an emerging problem, with several series report-

ing an incidence ranging from 0.4% to 4% (1,5,12, 22,24). With an increasing number of patients undergoing resurfacing, the statistics for fracture and other modes of failure are expected to rise further (18).

CASE REPORT

A 40-year-old man had undergone bilateral BHR procedures three years prior to presentation. These were performed for avascular necrosis of unknown cause. Both procedures were uneventful, without any intra- or post-operative complications. He was cycling in the French part of the Alps, where unscheduled road works forced him onto a narrow and rocky lane. He lost control of his bicycle, went over a boulder and fell through a height of 20 feet into a dried riverbed. He sustained a left-sided proximal femoral fracture and an ipsilateral ankle

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Fig. 1. — AP radiograph showing type and extent of fracture in the left proximal femur.



Fig. 2. — Immediate post-op AP radiograph showing the mode of fixation of the fracture.

fracture. The hip fracture was intertrochanteric (OTA type 31-A2.2) with metaphyseal fragmentation and a minor subtrochanteric extension (16). The patient was keen on retaining his resurfacing prosthesis and elected to be repatriated back to the UK. The receiving surgical team also felt that conversion to a total hip arthroplasty was not feasible given the subtrochanteric extension of the fracture (Fig. 1).

The patient was positioned on the traction table and the fracture was reduced closed with minor valgus angulation. A 4.5 mm proximal femoral locking compression plate (LCP, Synthes®, Welwyn Garden City, UK) was used to stabilise the fracture, with three cannulated locking screws (two 7.3 mm and one 5 mm) through the proximal portion of the plate. Care was taken to position the screws in the femoral neck away from the resurfacing stem (Fig. 2). The ankle fracture was stabilised in the same setting using standard osteosynthesis technique. Postoperative management included bed rest for 6 weeks with active and passive exercises to increase range of motion, followed by 6 weeks of

partial weight bearing on crutches. At 18 weeks following surgery, the patient had regained a pain-free and full range of movement. He was bearing his weight fully through the operated leg. His Harris Hip Score at the last appointment was 100. Radiographs confirmed fracture union (Fig. 3).

DISCUSSION

A review of literature reveals two distinct fracture patterns emerging, i.e. 'atraumatic' and 'traumatic'. The predominant mode is an insidious 'atraumatic' fracture, which is usually intracapsular and frequently undisplaced or minimally displaced at presentation. This was the commonest cause for revision in Carrother's review of 5000 resurfacings, with a prevalence of 1.1% (5). Predisposing factors mentioned include varus malalignment (2,17,19), notching of the femoral neck (4,22,25), surgeon's learning curve (12), female sex (22), obesity (12), and post-operative avascular necrosis (23). Mean time to fracture is earlier in males than females (0.7 years v/s 2.7 years) (5). Cossey and Cumming have report-



Fig. 3. — AP radiograph at 12 weeks

ed successful non-operative management (6,7). Barring these few cases where the resurfacing implants were successfully retained, most series have reported revision arthroplasty as the definitive treatment (5,22).

The other pattern is of an epidemiologically and mechanistically different periprosthetic fracture. This occurs in the setting of major trauma, and does not have a defined incidence or timescale (18). For this subgroup of patients, the resurfacing works very well, until they sustain a high-energy injury. The presented case of a mountain biking accident in the Alps exemplifies this mode of injury, and the greater activity level and consequent risk profile in this subgroup. This type of fracture is predominantly extracapsular (3,11,14,15,18,26,27) though subcapital fractures can occur (10,20,29). Displacement and multifragmentation is common (3,15,18,27), and

other adverse features like reverse obliquity pattern (15) and diaphyseal extension (3) have been reported. The sudden non-physiologic loading (15) through a proximal femur with altered biomechanics may induce fracture initiation and propagation through variably distributed stress raisers, resulting in different fracture configurations. The 'retain' versus 'replace' decision is significantly influenced by these anatomical factors. Tables I and II summarise the epidemiology and management strategies employed for traumatic periprosthetic fractures reported to date.

Non-operative management of these 'traumatic' fractures has yielded variable results. Sharma described an intracapsular fracture occurring three months after resurfacing in a female patient (20). Patient non-compliance and suboptimal monitoring by the treating team contributed to varus malunion. Morgan reported successful union in two cases of minimally displaced intertrochanteric fractures, two and eleven years respectively after the index procedures (14). These were treated with six weeks in traction, followed by a gradual return to weight bearing.

Most traumatic fractures are displaced with or without the adverse anatomical features mentioned above. Surgical intervention to retain the implant and treat the fracture needs careful consideration. Principles include a suitable implant, a suitable mode of stabilisation, and optimal reduction, preferably in valgus so as to offset the compromising stresses on the medial buttress. Adequate purchase in the bone is essential to achieve optimal inter-fragmentary compression. The resurfacing stem occupies the centre of the femoral neck, and if it has been cemented, the cross-sectional area of the available bone is reduced further. Resurfaced femoral necks are predisposed to avascular necrosis (23,28), and any subsequent metalwork traversing the neck could potentiate this and lead to failure (29). Table III depicts the profiles of a few implants reported in literature. A low-profile implant would be advantageous in negotiating around the resurfacing stem in the femoral neck. A sliding hip screw or proximal femoral nail is precluded by the relatively large outer thread diameters of their lag screws.

Table I. — ‘Traumatic’ type of periprosthetic fractures around resurfacing hip implants, as reported in literature to date

Author	Centre	No. of patients	Sex	Age at Resurfacing	Implant	Time since Resurfacing
Aning (3)	Cheltenham, UK	1	M	58	BHR®	2 years
Sharma (20)	Airdrie, UK	1	F	55	Cormet®	3 months
Kutty (10)	Calgary, Canada	1	M	57	BHR®	2 months
Weinrauch (26)	Coventry, UK	1	M	67	Cormet®	19 months
Morgan (14)	Worcester, UK	2	F	67	BHR®	11 years
			M	67	BHR®	2 years
Orpen (15)	Oxford, UK	2	M	52	Conserve®	2 years
			M	54	BHR®	3 months
Sandiford (18)	London, UK	1	M	64	BHR®	4 years
Zustin (29)	Friedrichshafen, Germany	1	M	55	BHR®	18 weeks
Merreddy (13)	Wirral, UK	1	M	68	BHR®	15 months
Whittingham-Jones (27)	Chelmsford, UK	1	F	32	BHR®	4 years
Lein (11)	Dresden, Germany	1	M	29	BHR®	2 years

Implants : Birmingham Hip Resurfacing (Smith & Nephew®), Cormet (Stryker®), Conserve® (Wright Medical Technology, Inc.®).

Table II. — Management strategies employed for traumatic periprosthetic fractures reported in literature to date

Author	Type of fracture	Strategy	Result
Aning (3)	Intertrochanteric /Subtrochanteric	Reconstruction nail	Union
Sharma (20)	Intracapsular	Non-operative	Varus Malunion
Kutty (10)	Intracapsular	Two cannulated cancellous screws (Synthes®)	Union
Weinrauch (26)	Intertrochanteric (Kyle 2)	130 degree angled blade plate, 4-hole, 80 mm (Synthes®)	Union
Morgan (14)	Intertrochanteric	Non-operative	Union
	Intertrochanteric	Non-operative	Union
Orpen (15)	Intertrochanteric	Distal femoral non-contact bridging, locking plate (Zimmer®)	Union
	Reverse oblique pertrochanteric	Distal femoral non-contact bridging, locking plate (Zimmer®)	Union
Sandiford (18)	Intertrochanteric / Subtrochanteric (Kyle 4)	THR with cerclage and interfragmentary screw	Pain-free and mobile
Zustin (29)	Intracapsular	Three cannulated cancellous screws (Synthes®)	AVN and collapse ; revised to THR
Merreddy (13)	Basicervical	Three cannulated cancellous screws (Synthes®)	Union
Whittingham-Jones (27)	Intertrochanteric / Subtrochanteric	Contoured proximal femoral DCP (Synthes®)	Union
Lein (11)	Intertrochanteric (OTA type 31-A2.1)	Three cannulated cancellous screws (Synthes®)	Union

Extramedullary fixation with cannulated screws can work if the fracture remains at a suitable level, and is not significantly displaced or fragmented.

Favourable results have been reported for intracapsular (10), basicervical (13), and intertrochanteric fractures (11). Cannulated screws would theoretical-

Table III. — Different implants and their mechanical 'profiles'

	Implant	Manufacturer	Maximum implant height / diameter in neck	Angle of implant in neck
1	Cannulated screws	Synthes®	7.3 mm	Variable
2	Angled blade plate	Synthes®	6.5 mm	130°
3	NCB™ locking plate screws	Zimmer®	4 mm, 5 mm (two sizes)	90°-120° (polyaxial)
4	DHS lag screw	Smith & Nephew®	12.7 mm	130°-150°, in 5° increments
5	DHS lag screw/blade	Synthes®	12.5 mm	130°-150°, in 5° increments
6	PFNA helical blade	Synthes®	12.5 mm	125°, 130°, 135°
7	IMHS lag screw	Smith & Nephew®	12.7 mm	125°, 130°, 135°
8	Gamma Nail lag screw	Stryker®	12 mm	120°, 125°, 130°

ly fail for a more complex fracture pattern e.g. metaphyseal fragmentation and diaphyseal extension, which impose mechanical considerations of their own.

Of plate-screw constructs, a 130°/4-hole/80 mm blade plate has been used to fix a moderately fragmented intertrochanteric fracture (26). The blade has a curved surface with a sagittal height of 6.5 mm, and gains purchase in the femoral head by circumventing the resurfacing stem along its inferior aspect. Orpen *et al* improvised by using distal femoral non-contact bridging (NCB) locking plates (Zimmer®) in their two intertrochanteric fractures (15). The screws have an outer threaded diameter of 5mm and a polyaxiality of 30°. When the plate is flipped around, they lie conveniently at 120° (30° + 90° = 120°) in the femoral neck. Whittingham-Jones *et al* have similarly used a contoured proximal femoral DCP (Synthes®) for a significantly fragmented intertrochanteric fracture (27). An offshoot of these DCPs is the periarticular plating system (Synthes®), which includes the proximal femoral LCP used in our case.

To our knowledge, this is the first documented use of this implant for this type of fracture. The pre-contoured proximal portion of the LCP conforms to the greater trochanter. The proximal two holes on the plate are threaded and accept any combination of the three types of 7.3 mm cannulated screws. These can be locking screws with threaded conical heads, thereby giving a fixed-angle screw-plate construct. Alternatively, smooth conical head screws can be used to compress the plate to the bone only (fully threaded) or to achieve interfrag-

mentary compression as well (partially threaded). The proximal most two screws are 95° and 120° respectively (9) ; both need to evade the resurfacing stem, and careful positioning of the plate on the bone is crucial. The third locking hole (135°) is threaded to accept a 5 mm cannulated locking screw, which has an unimpeded run in the inferior quadrant of the neck abutting the calcar. Distally, the plate is secured with bicortical 4.5 mm screws through Combi-holes. The plate can be tensioned using a tensioning device to compress the fracture further. For subtrochanteric or multifragmented fractures, the plate can be left un-tensioned to serve as a bridging construct. A longer plate could suffice for fractures with long diaphyseal extension. Alternatively, a reconstruction nail can be used (3).

CONCLUSION

The incidence of 'traumatic' type of periprosthetic fractures around resurfacing arthroplasties is increasing. The proximal femoral LCP is an attractive option for the more fragmented fractures where the intention is to retain the implant. For fractures which cannot be salvaged however, a revision arthroplasty could be considered.

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