



## Pressfit ceramic arthroplasty of the first metatarsophalangeal joint A short-term review

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Several prostheses are available for replacement of the first metatarsophalangeal joint. The aim of our study was to review our results with the Moje press-fit ceramic implant.

Our study included seven procedures in six patients with a mean age of 60.2 years followed for a mean of 35 months (range : 24 to 43 months). We found a significant ( $p < 0.001$ ) improvement of the Visual Analogue Score from 7-8 to 1-2 and of the Foot Function Index from 75.6 to 8.6. We recorded a mean postoperative dorsiflexion of  $29.2^\circ$  and plantar flexion of  $12.1^\circ$ . Apart from slight cortical recession in one case, probably related to overuse, there was little evidence of osteolysis or loosening of implants and no major complication has been noted in any of the patients.

The pressfit design seems to have overcome the disadvantages of the previous screw fit prosthesis which had been reported to have complications related to metallosis around the titanium screw.

Various implants have been devised from the time Endler (*in 13*) used bone cement to reconstruct the base of the proximal phalanx. Silicon implants have been widely used but they have been found to have a variable failure rate especially due to interaction with the surrounding soft tissue (*1, 11, 14*). Other materials which have been in use are stainless steel, cobalt chromium, titanium, ceramic, UHMWPE, etc (*13, 16*).

The Moje Ceramic toe implant (*3*) is made of zirconium oxide and was developed in 1994 by a German orthopaedic surgeon, Dieter Werner and a ceramic engineer Hans Jurgen Moje. The original implant was screw fit but complications of osteolysis and metallosis led to the replacement of the design with the pressfit one.

The pressfit implant is a two-component ceramic prosthesis coated with apatite and fosterite crystals (Bioverit 1) (*7*). It relies mainly on interference fit coupled with osseointegration encouraged by the

### INTRODUCTION

The first metatarsophalangeal (MP) joint plays an important part in propulsion and normal gait of the human body. Degenerative disease of the joint not only causes pain and loss of motion of the great toe but also affects the normal biomechanics. The accepted treatments for this problem have been arthrodesis and resection arthroplasty, but considering the important role the first MP joint plays in normal gait, these may not be acceptable options in the future.

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Bioverit coating. The coating forms a closed contact with the substrate and possesses a good adhesive strength.

This short term review presents our experience with the Moje pressfit ceramic implants with specific reference to radiological evidence of loosening or osteolysis.

## MATERIAL AND METHODS

Our retrospective study includes seven toes in six patients with ages ranging from 55 to 68 years. The study included surgeries done between November 2000 and June 2002 at Fairfield Hospital, Bury, U.K. The indication was Grade III hallux rigidus in all the cases.

A dorsomedial approach was used. After preparation of the capsule, approximately 4 mm of bone was resected from the metatarsal head and 4 mm from the base of the proximal phalanx. Mobility was next checked with an aim to achieve 70° dorsiflexion and 30° plantar flexion. This could be obtained by loosening the sesamoids and the tendons and resecting the osteophytes and any other tissue impeding mobility. Appropriate trials were selected and mobility and tension checked with both trial implants in position. Ideally the trial implant should be 5 mm smaller than the diameter of the cut bone surface. If needed, further resection of the joint was done and mobility was tested with correct size trials. Guide wires were placed in the centre of the cut surface at 90° and the bone drilled over the wire to the stop mark indicated. Expanders were used to prepare the insertion site. Implants were next inserted and mobility tested. The capsule was repaired over the reconstructed joint.

Postoperatively, heel walking was allowed with the use of crutches. After two weeks full weight bearing was allowed. Physiotherapy was started two weeks following surgery after suture removal.

The patients were assessed taking into account subjective, clinical and radiological criteria. The subjective assessment was on the basis of pain relief both at rest and during load bearing ; ability to load bear during normal walking and according to a Visual Analogue score. The ability to load bear was determined by the gait pattern as observed clinically and any subjective feeling of limp or tendency to use the other limb while walking.

Clinical assessment was based on range of motion and any other problem like tenderness, swelling and instability. The range of movement was assessed in relation to the first metatarsal axis.

The Foot Function Index (2) was used during review. It is a validated scoring system with subscales in three groups – pain, disability and activity limitation. The preoperative Visual Analogue Score and the Foot Function Index was obtained retrospectively.

Paired t-test was used to compare the pre and postoperative scores.

Radiologically we looked for signs of loosening, collapse, osteolysis and resorption.

## RESULTS

Seven first metatarsophalangeal joint replacements were done in six patients using the Moje pressfit Ceramic prosthesis (table I).

The mean age was 60.2 years with a range between 55 to 68 years.

The study included three females and three males with one male patient having surgery on both feet at two different sittings.

The mean BMI of the patients was 24.75 kg/m<sup>2</sup> (range : 23.67 to 27.8).

One patient was involved in secretarial work, one with bilateral surgery was an engineer with work involving long walks, one was involved in finance and two ladies were housewives while one gentleman had retired from work.

The mean follow-up was 35 months with a minimum of 24 months and a maximum of 43 months.

Patients were asked to compare the preoperative pain and discomfort with postoperative relief on a visual analogue scale. There was a significant score improvement ( $p < 0.001$ ) from a mean of 7-8 to 1-2.

There was no pain at rest or during weight bearing in any of the patients. Three patients reported slight discomfort during weight bearing but only after prolonged walking. There was no restriction in load bearing in any of them.

There was no swelling or tenderness in any of the joints. All the toes were stable.

Range of movement was assessed in relation to the first metatarsal axis. We recorded a mean dorsiflexion of 29.2° and plantar flexion of 12.1°. The maximum dorsiflexion achieved was 35° and minimum 25°. Maximum plantar flexion was 15° and minimum 10°.

Table I. — Results

Patient No.		1	2	3	4	5	6	7
Age (years)		55	60	57	60	62	61	68
Sex		F	M	M	M	M	F	F
Side		L	L	L	R	R	L	L
Pain	Rest	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	WB	Nil	Nil	Slight	Nil	Nil	Slight	Slight
VAS	Preop	8	6	8	7	7	7	7
	Postop	1	1	2	1	1	1	1
ROM	DF	35	25	30	25	35	30	25
	PF	15	10	10	10	15	15	10
FFI	Preop	74	68	84	70	72	83	78
	Postop	10	0	16	0	0	25	9
Follow-up (months)		43	43	37	36	34	27	24
Radiological		NAD	RLL	NAD	RLL	NAD	NAD	NAD

WB : Weight Bearing – VAS : Visual Analogue Score – ROM : Range of Motion – DF : Dorsiflexion – PF : Plantar Flexion – NAD : No Abnormality Detected – RLL : Radiolucent Line – FFI : Foot Function Index.

The mean preoperative Foot Function Index was 75.6 (range 70-84), which improved significantly ( $p < 0.001$ ) to a mean of 8.6 (range 0-25) postoperatively.

Radiological review showed no evidence of loosening, bone resorption, collapse, osteopenia or lytic lesion in five patients. In the one patient with bilateral toe replacement a radiolucent line could be identified around the prosthesis (fig 1, 2).

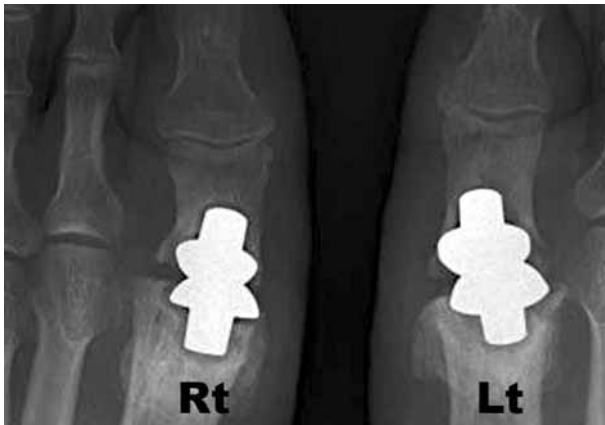
No complication was noted in any of the patients. Slight crunching sound could be elicited in three of the toes. Only one patient had noticed it and was occasionally bothered with it, although in no way did it restrict his activity.

## DISCUSSION

The first metatarsophalangeal joint is a complex synovial enarthrodial joint which moves in three planes. In the sagittal plane it flexes dorsally and plantarly for propulsion, adducts and abducts in the transverse plane for stability and rotates in the frontal plane to accommodate the dual role the foot plays in rigid lever adaptor function (15). During the

gait cycle the great toe dorsiflexes not only at heel off at the end of the stance phase, but also during the swing phase with dorsiflexion of the foot to aid in ground clearance. The two sesamoid bones in the plantar aspect play an important role in absorption of the force and smooth propulsion. It has been widely believed that the origin of degenerative disease of the first metatarsophalangeal joint is microfracture and eventual wearing of the articular surface of the sesamoids. The complex anatomy of the first metatarso-phalangeal joint and the important biomechanical role it plays require special thought and consideration before choosing the appropriate treatment modality for degenerative disease of this joint.

Arthrodesis of the joint is advised in severe hallux rigidus (Grade III) but it abolishes the normal mobility of the joint (4, 5, 9). Pedobarographic studies have demonstrated that despite good subjective results, fusion of the joint leads to a significant decrease in step length with loss of ankle plantar flexion at toe off phase in addition to a reduction in both ankle torque and ankle power at the push off phase (8). Resection arthroplasty results in an



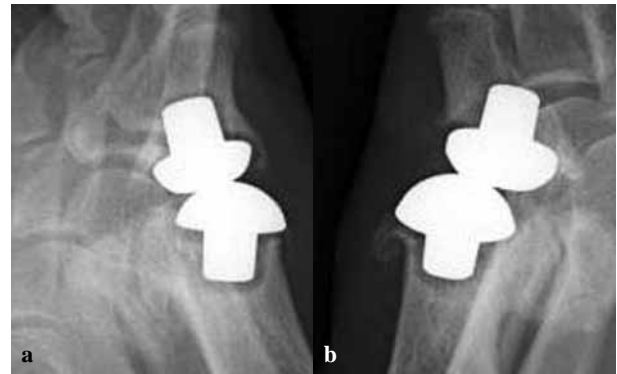
**Fig. 1.** — A-P view — Radiolucent line around prosthesis — Walks 10 miles / day.

unstable joint and metatarsalgia (20). Excision arthroplasty with interposition of soft tissue has also been shown to have good subjective and objective results (6, 12).

The history of metatarsophalangeal joint arthroplasty goes as far back as 1952 when Swanson (13) first designed a metal hemispherical cap with a tapered stem for the first metatarsal head. Since then there have been several attempts to find an ideal implant, with variable results (13, 16). The persistence of the search goes on to emphasise the significance that has been attributed to this seemingly innocuous joint. The goal has been to find an implant which is biocompatible and provides long term elimination of pain and restores stability of the joint without compromising the mobility. Various implant materials have been tried. The properties primarily expected of the material are biocompatibility, maximum bioactivity, good mechanical strength, high degree of chemical resistance especially against body fluids and good machinability (18).

Silicon prostheses, although providing good subjective results, have been associated with osteolysis around the prosthesis (11, 17).

Ceramic implants have been used in the past by Giannini and Moroni in 1991; they used alumina, but its performance was found to be poor, with loosening and breakage of the implant (13).



**Fig. 2.** — **a** (left) and **b** (right). Lateral view radiolucent line around prosthesis — walks 10 miles / day.

Moje Ceramic implants made of zirconium oxide designed by Werner and Moje have been found to be biocompatible and acceptable. The initial problems with screw fit implants (19) such as loosening and metallosis related to the titanium screw lead to the development of the newer press fit design coated with mica apatite bioverit which possesses a high long term stability and forms an interfacial bond with the tissues (3).

With follow-up of up to 43 months without any complications it seems that the implants have been well tolerated by the patients. They do not interfere with the normal weight bearing. All the patients had a significant improvement in the Visual Analogue Score from a mean of 7-8 to 1-2 and the Foot Function Index from a mean of 75.6 preoperatively to 8.6 postoperatively. This does indicate that the patients had a reasonable level of activity.

All our patients have been satisfied with the surgical procedure. This compares favourably with the 77.8% satisfaction rate reported by West and Moir (7) with a mean follow-up of 13 months and 85% reported by Werner (19) after a follow-up of 3 years.

In none of the cases did we find any clinical evidence of loosening or reaction to the prosthesis as had been found with the previous screw fit design. In one patient with bilateral toe replacement, we did note a radiolucent line around the prosthesis on

both sides, but there was no evidence of radiological osteolysis or loosening (fig 1, 2). The patient is doing very well with a Foot Function index of 0 (table I) and in fact walks about ten miles every day without any problem. The radiolucent line may be related to overuse of the toes. The patient is under regular follow-up to detect any early symptomatic loosening of the prosthesis.

Three patients said that they had slight pain but it was only after prolonged walking and after a long drive when they had to use the clutch multiple times and in no way did the implant restrict them.

We did note that the range of movement was not as good as has been previously reported. A mean dorsiflexion of 29.2° and plantar flexion of 12.1° was recorded in comparison to 57.6° dorsiflexion and 10.5° plantarflexion as reported by Werner (19). West and Moir (7) have reported a similar range of movement of 20-40° dorsiflexion and 10-20° plantar flexion. The lesser range of motion did not seem to interfere with the activities and the gait clinically. We did not do any formal gait analysis with pedobarographic measurements to assess if it interfered with the normal gait.

Previous studies have reported good patient satisfaction after first metatarsophalangeal joint replacement, with improvement in plantar pressure distribution despite limited range of movement (10). It has been found to offer distinct advantages over the other methods of treatment in the treatment of end stage hallux rigidus.

## CONCLUSION

This study although limited by its retrospective structure and a small series has a mean follow-up of 35 months and shows little evidence of loosening of the prosthesis or osteolysis both clinically and radiologically. The implant has been tolerated well by all the patients. It seems to be an improvement over the previous design and is a good and relatively simple procedure with gratifying results. While the Moje Pressfit Ceramic implant may not be a final answer, our review does show that it is a reasonable and acceptable option when replacement of the first metatarsophalangeal joint is being considered. A long term follow-up with a larger series of

patients is obviously desirable before arriving at a final conclusion.

## REFERENCES

1. **Bonet J, Taylor DT, Lam AT, Williams E, Keane LA.** Retrospective analysis of Silastic implant arthroplasty of the first metatarsophalangeal joint. *J Foot Ankle Surg* 1998 ; 37-2 : 128-134.
2. **Budiman-Mak E, Kendon JC, Kathryn ER.** The Foot Function Index : A measure of foot pain and disability. *J Clin Epidemiol* 1991 ; 44 : 561-570.
3. **Carl G, Moje HJ, Werner D, Russel C.** Coating of Bioverit 1 glass ceramic on zirconia prosthesis. *Bio-ceramics* 1996 ; 9 : 119-122.
4. **Coughlin M, Mann R.** Arthrodesis of the first metatarsophalangeal Joint as salvage for failed Keller procedure. *J Bone Joint Surg* 1987 ; 69-A : 68-75.
5. **Coughlin MJ, Shurnas PS.** Hallux rigidus : Grading and long-term results of operative treatment. *J Bone Joint Surg* 2003 ; 85-A : 2072-2085.
6. **Coughlin MJ, Shurnas PJ.** Soft-tissue arthroplasty for hallux rigidus. *Foot Ankle Int* 2003 ; 24 : 661-672.
7. **David-West KS, Moir JS.** Moje ceramic prosthetic metatarsophalangeal joint replacement. *The Foot* 2002 ; 12 : 43-46.
8. **DeFrino PF, Brodsky JW, Pollo FE, Crenshaw SJ, Beischer AD.** First metatarsophalangeal arthrodesis : a clinical, pedobarographic and gait analysis study. *Foot Ankle Int* 2002 ; 23 : 496-502.
9. **Fitzgerald J.** A Review of long-term results of arthrodesis of the first metatarsophalangeal joint. *J Bone Joint Surg* 1969 ; 51-B : 488-493.
10. **Fuhrmann RA, Wagner A, Anders JO.** First metatarsophalangeal joint replacement : the method of choice for end stage hallux rigidus ? *Foot Ankle Clin* 2003 ; 8 : 711-721.
11. **Granberry W, Noble P, Bishop J, Tullos H.** Use of hinged silicone prosthesis for replacement of the first metatarsophalangeal joint. *J Bone Joint Surg* 1991 ; 73-A : 1453-1459.
12. **Hamilton WG, Hubbard CE.** Hallux rigidus. Excisional arthroplasty. *Foot Ankle Clin* 2000 ; 5 : 663-671.
13. **Hetherington VJ, Cwikla PS, Malone M.** Review of first metatarsophalangeal joint implants. In : Hetherington VJ (ed). *Hallux Valgus and Forefoot Surgery*. Churchill Livingstone, New York, 1994. pp 347-358.
14. **Needelman L.** The microscopic interaction between silicone and the surrounding tissues. *Clin Podiatr Med Surg* 1995 ; 12 : 415-423.
15. **Payne CB, Dannanberg H.** Sagittal plane facilitation of the foot. *Aus J Podiatr Med* 1997 ; 31 : 7.
16. **Schweitzer J, Bentrem DJ, Gabriel MC et al.** An overview of first metatarsophalangeal joint implant arthroplasty. *J Long Term Eff Med Implants* 1995 ; 5 : 93-104.

17. **Verhaar J, Bulsta S, Walenkamp G.** Silicone arthroplasty for hallux rigidus. Implant wear and osteolysis. *Acta Orthop Scand* 1989 ; 60 : 30-33.
18. **Vogel W, Holand W.** The development of bioglass ceramic for medicine. *Angew Chem Int Ed Engl* 1987 ; 26 : 527-544.
19. **Werner D.** A Ceramic prosthesis for hallux rigidus. *The Foot* 2001 ; 11 : 24-27.
20. **Yu GV, Sellars CS, Shook JE, Karlock LG.** Iatrogenic deformities of the first ray. *Clin Podiatr Med Surg* 1996 ; 13 : 367-422.