UPDATE ON FIRST METATARSOPHALANGEAL JOINT IMPLANT ARTHROPLASTY

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INTRODUCTION

Implant arthroplasty, once touted as a cure-all for deformities of the first metatarsophalangeal joint, has been tested over time with varying degrees of success. The first implants, described by Seeburger, were constructed of vitalium. Many of these implant procedures failed, secondary to resorption of bone around the implant. Bony resorption was presumed to occur due to a lack of compliance of the implant, in comparison to the bone stock. Simply stated, these implants were too rigid. Following the failure of vitalium implants, many other materials were explored, including acrylic, silicone, teflon, dacron, durallium, and stainless steel. Due to a consistent lack of success with these materials, the search for the ideal implant material continues today.

SILICONE IMPLANTS

More recently, silicone was deemed to be a viable material for bioimplantation. Silicone was touted as the superior material due to its low potential for tissue reaction, longevity of pliability, and stability over time. Today, Silastic, a medical grade silicone rubber, is the most commonly used implant material for the first metatarsophalangeal joint.

Silastic implants, first designed and used by Swanson in 1967, were designed for implantation following a Keller bunionectomy. This implant was designed to replace the arthritic articular surface of the base of the proximal phalanx with a silastic articular surface. Many variations of this basic design have been developed, including the addition of dacron mesh to the stem of the implant to provide stabilization and allow for fibroblastic ingrowth, and the availability of an angulated stem in an attempt to provide normal hallux abduction.

In 1971, Niebauer and Landry used the first flexible hinge implants in the hand for replacement of arthritic interphalangeal joints. Swanson followed in 1974, with the use of a double-stemmed, flexible hinge implant made of a high performance silicone elastomer, in the first metatarsophalangeal joint. Variations and modifications of this implant are currently produced and implanted in the foot. Titanium grommets, designed to press fit into the metatarsal head and proximal phalanx base, are considered advantageous in reducing both bone and implant failure. These devices theoretically contribute to the implant's longevity, and reduce stress and subsequent breakdown of the implant caused by direct contact with bone.

Currently there are two types of implant systems available for first metatarsophalangeal joint replacement. These are referred to as either single or dual component systems. The single component systems include the silastic hinged implants such as the Swanson, Lawrence and Laporta models. Titanium grommets may be included with these systems if so desired. Less commonly used are the silastic hemi-implants, which are also available as a combination titanium-silastic device, for replacement of the proximal phalanx base.

The dual component systems currently available have been designed to resemble those utilized in hip and knee joint reconstruction. Three models have recently been introduced for replacement of the first metatarsophalangeal joint.

INDICATIONS FOR JOINT REPLACEMENT

Indications for the use of first metatarsophalangeal joint implants include patients presenting with degenerative joint disease (osteoarthritis), rheumatoid arthritis, hallux limitus and rigidus, iatrogenic deformities, and for general reconstructive purposes. The use of implants in the first metatarsophalangeal joint is primarily indicated in the geriatric population. Implantation in the younger patient should be avoided if possible, due to the limited life-span of these devices, even under optimal circumstances.

COMPLICATIONS

Complications associated with first metatarsophalangeal joint replacement include failure of the implant secondary to normal or abnormal wear, infection (higher incidence than other 1st MPJ procedures), osseous resorption of the surrounding bone, avascular necrosis, and pathologic fracture of the phalanx or metatarsal. Another less common complication is silicone granuloma formation with lymphadenopathy at proximal sites in the body. Sammarco and Tabatowski reported a case in which a patient developed femoral lymphadenopathy three years following implant arthroplasty.

DUAL COMPONENT 1ST MPJ IMPLANT DEVICES

The first dual component system was developed in 1990 by Koenig. The Koenig Total Great Toe Implant (Biomet, Warsaw, IN) is a two component prosthesis made of titanium alloy and polyethylene. The prosthesis includes specific instrumentation which allows for precise fitting of the implant. Preliminary results, as reported by Koenig, were satisfactory at 18 months postoperatively. Experience has been limited with this particular device, however, the few patients at the authors' institution who have been implanted with this system have satisfactory results to date.

The Acumed Great Toe System (Acumed, Beaverton, Or) is the most recently-approved dual component system. This system was developed and modified based on results from a center of rotation study performed by the initial researchers. This study compared the Acumed device to the natural functional anatomy of the first metatarsophalangeal joint, as well as other single and dual component systems. This device appears to be theoretically sound by its design, based on studies performed by the manufacturer. The Koenig, and Acumed implants, as well as the Bioaction implant, (which we have minimal experience with), may be selectively utilized in the appropriate patient. Long term follow-up will be paramount in evaluating these devices for implant arthroplasty of the first metatarsophalangeal joint.

CLINICALLY ILLUSTRATED THE ACUMED GREAT TOE SYSTEM

A 53 year old white female presented with a painful hallux limitus deformity of the left first metatarsophalangeal joint. Passive dorsiflexory range of motion was approximately 10 - 15°. The patient opted for a joint implant, versus a Keller type procedure.

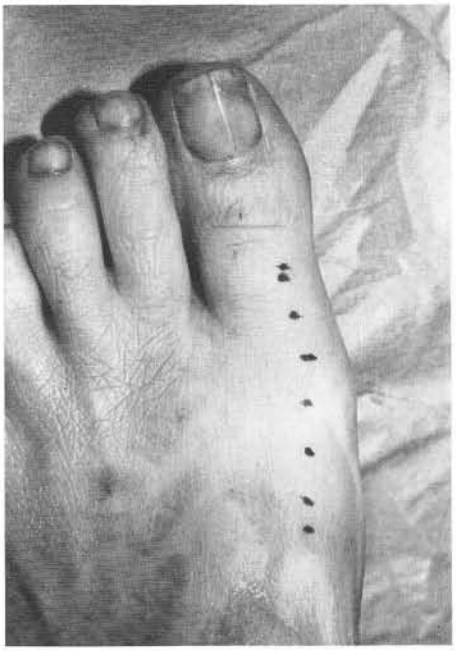

Figure 1. A standard dorsolinear incisional approach is utilized for exposure to the first metatarsophalangeal joint.

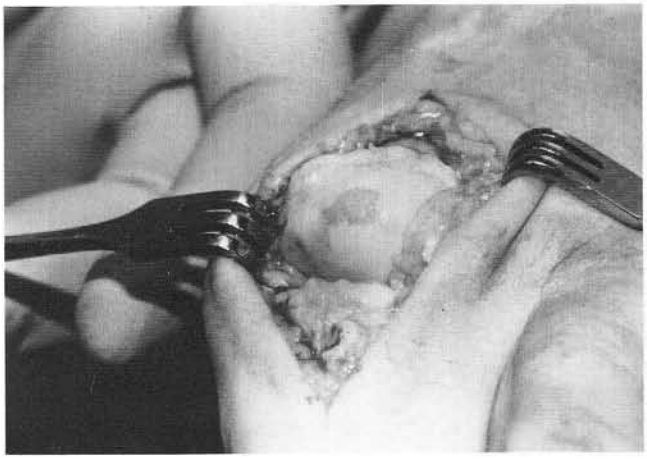

Figure 2. Capsular and periosteal tissue dissection is performed to expose the first metatarsophalangeal joint. Note the central cartilaginous defect and dorsal osteophytic lipping of the metatarsal head.

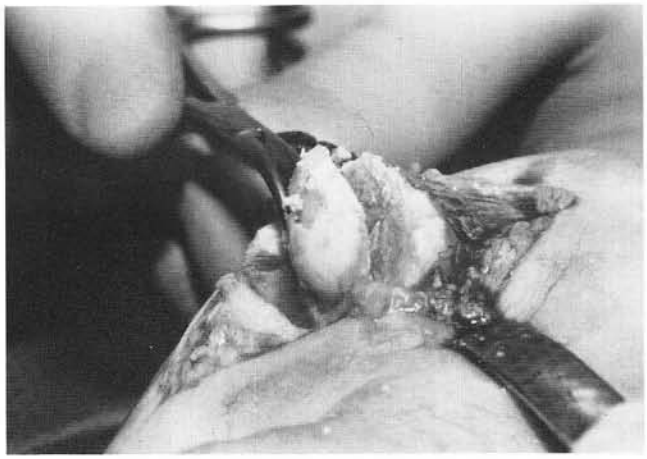

Figure 3. Minimal resection of the head of the first metatarsal is performed with the use of a metal jig. Care is taken to resect bone perpendicular to the long axis of the first metatarsal in both the sagittal and transverse planes.

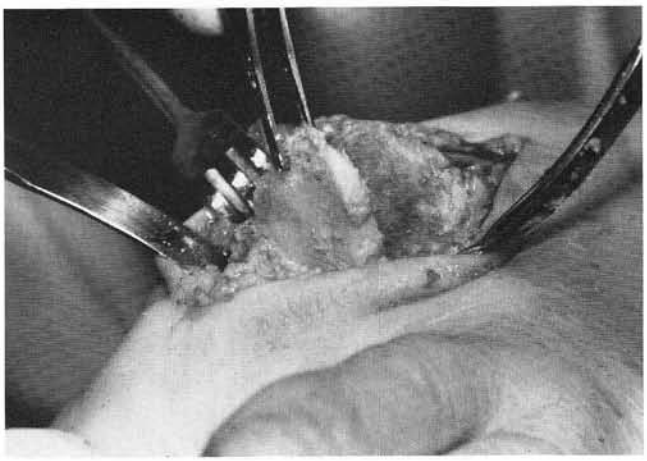

Figure 4. The proximal phalanx base cut is performed at this time. The goal is to resect a minimal section of bone, perpendicular to the long axis of the phalanx.

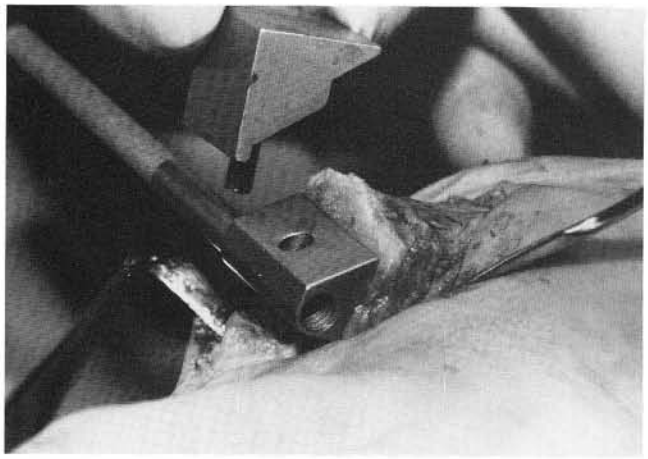

Figure 5. Following joint resection, the hallux is plantarflexed, and a chamfer guide is placed on the metatarsal head. The angled superior surface rests against the remaining metatarsal articular surface. This guide is then pressed into the remaining metatarsal head.

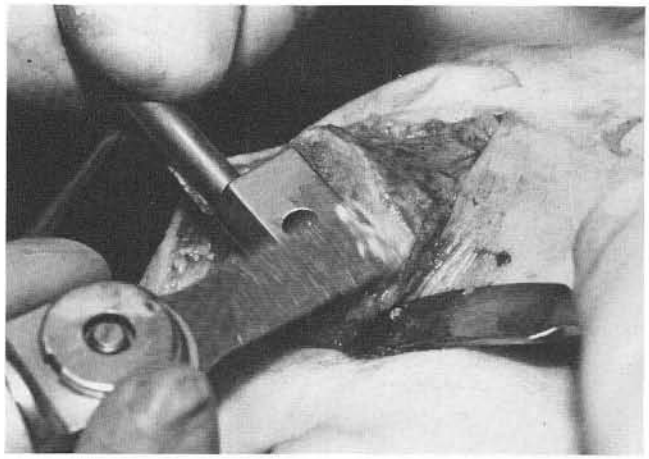

Figure 6. The angled superior surface of the chamfer serves as a cutting guide for the dorsal surface of the implant.

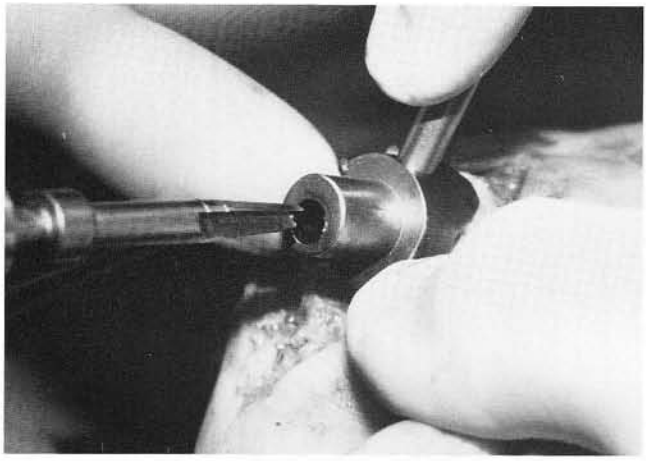

Figure 7. A drill guide is placed centrally on the first metatarsal head. The guide's dorsal surface is angulated proximally to seat on the chamfered metatarsal head. After proper positioning, the metatarsal head is reamed to receive the stem of the implant.

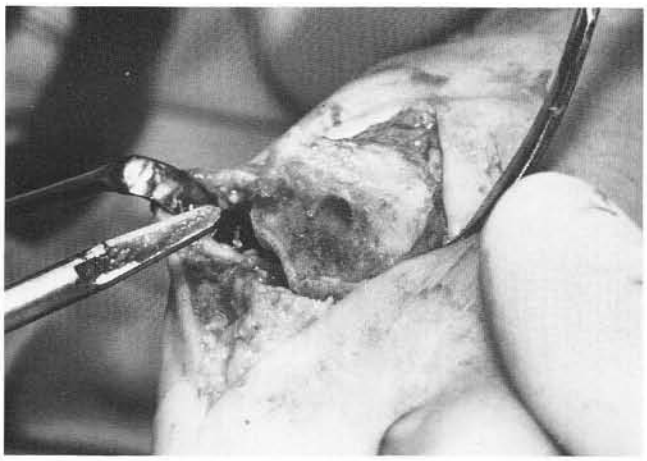

Figure 8. Appearance of the metatarsal head upon removal of the drill guide. The metatarsal is ready to receive the proximal component of the implant.

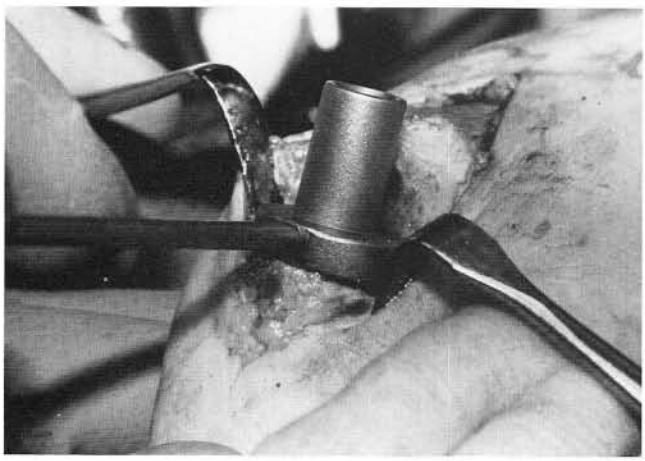

Figure 9. An appropriately-sized drill guide is placed centrally on the resected base of the proximal phalanx, and a hole is reamed to receive the distal implant stem.

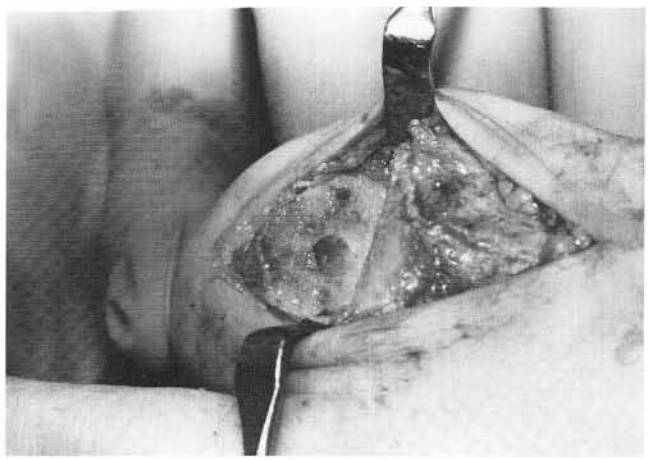

Figure 10. Appearance of the proximal phalanx base upon removal of the drill guide. The phalanx is ready to receive the distal component of the implant.

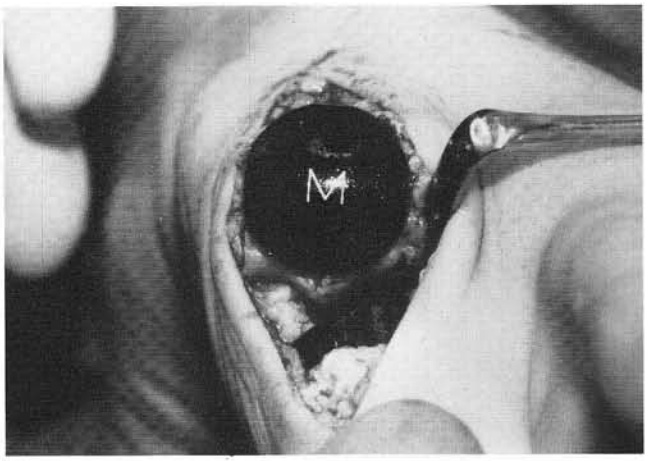

Figure 11. Trial seating of the proximal component on the metatarsal is demonstrated. Care is taken to examine the plantar surface of the implant sizer to avoid overhang and possible interference with sesamoid function. Trial seating of the distal component is also performed at this time, and joint range of motion is evaluated before final implantation is performed.

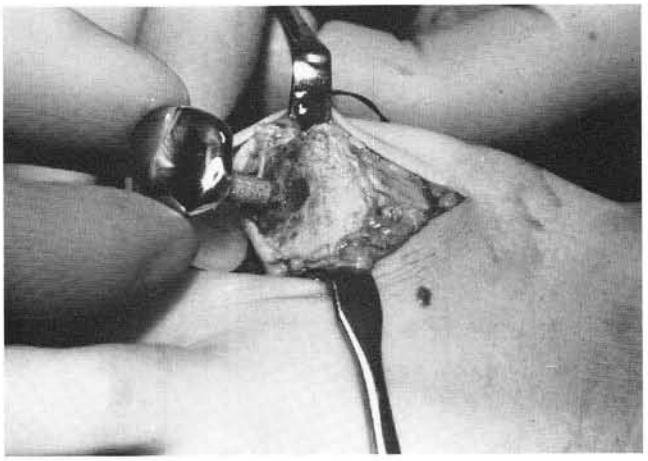

Figure 12. The proximal metatarsal component is inserted into the pilot hole. The implant components are press-fit and impacted into position. Minimal handling of the implant should occur, thus reducing the risk of contamination and possible infection.

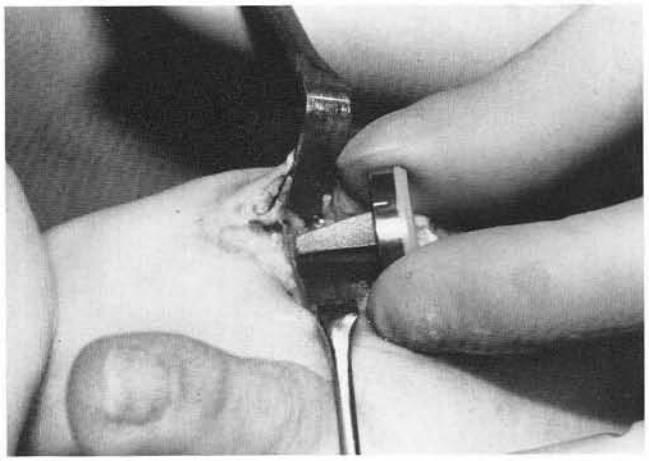

Figure 13. The distal component is inserted into the pilot hole in the proximal phalanx, and impacted into position.

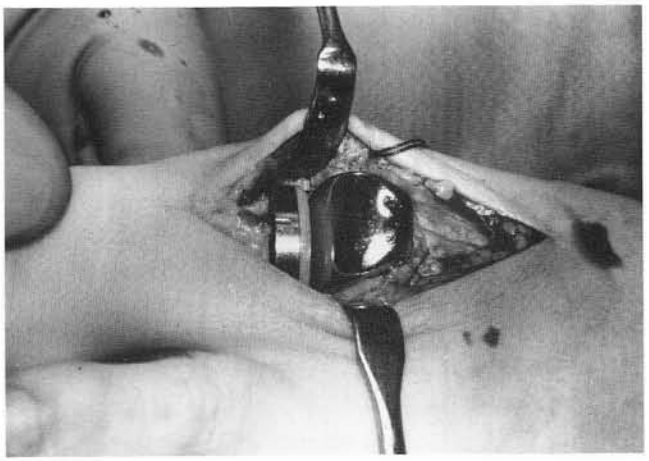

Figure 14. The two component system is now in place. Capsular closure is performed following successful implantation.

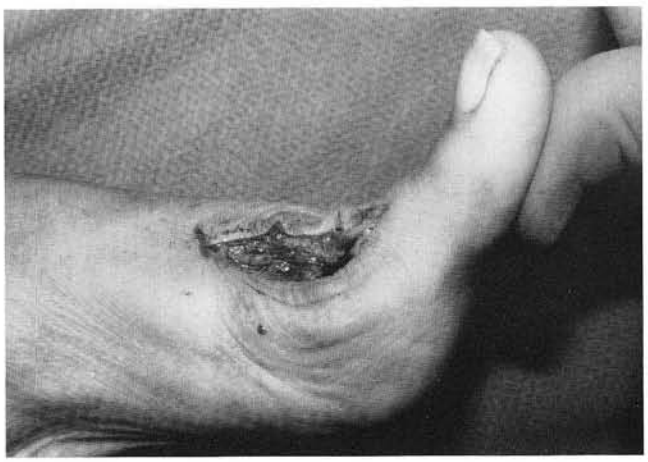

Figure 15. Passive range of motion of the hallux is performed to evaluate implant performance. Notice the amount of available dorsiflexion (approximately 80°).

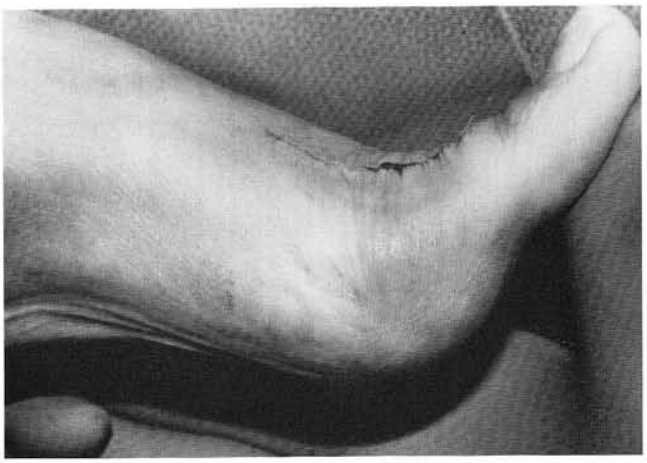

Figure 16. Following final closure, satisfactory range of motion is evident.

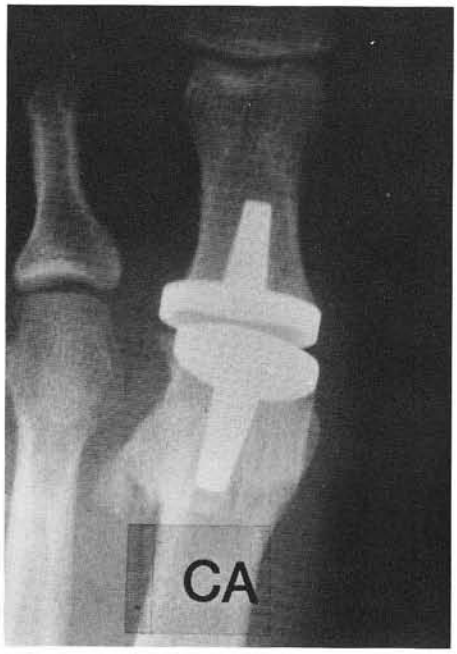

Figure 17. Postoperative radiograph demonstrating implant position.

SUMMARY

Total joint implant arthroplasty of the first metatarsophalangeal joint has had a variable degree of success with respect to long term, reproducible results. Recent advances in dual component systems, as illustrated in this presentation, add another modality to reconstruction of the first metatarsal-phalangeal joint. A variety of factors must be evaluated prior to performing a joint replacement procedure, including implant design, patient age, activity level, and expectations, risk versus benefit of a chosen surgical procedure, and personal surgical skill. This update on arthroplasty of the first metatarsophalangeal joint presents current information on a new two-component approach to total joint reconstruction, however more information needs to be evaluated before consistent results can be expected.

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