FOOT IMPLANT COMPLICATIONS AND FAILURES

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Painful joints afflicted with degenerative joint disease or severe deformity have always been difficult to treat. In the foot, the most common joints to be affected are the metatarsophalangeal joints, especially, the first metatarsophalangeal joint. (Fig. 1). The earliest surgical procedures were one of two types. Joint destructive procedures were performed where the bone on one or both sides of the joint was removed. Keller described removal of the base of the proximal phalanx of the hallux in 1904 and Mayo described removal of the head of the first metatarsal in 1908. This approach often lead to a flail hallux and/or dislocation and malposition. Postoperative pain at the joint was not typically a problem. However, transfer pressure to other parts of the foot was common.

A number of different authors modified these techniques by interposing a variety of tissues across the void created at the joint. Furthermore, they lengthened and tightened various structures to maintain digital alignment. Many felt that there had to be a better way!

Fig. 1. A painful first metatarsophalangeal joint with severe degenerative joint disease.

The second type of procedure involved fusion of the first metatarsophalangeal joint, described by McKeever in 1952. The cartilage was removed and the raw bony structures were opposed and allowed to unite. If fusion occurred, the pain at the joint was usually relieved, but joint motion was sacrificed. This often lead to altered gait patterns and increased pressure at other joints. Shoe gear limitations and irritations became problematic. The search for a better way continued!

Implantable joint replacements were thought to be the answer. In 1951, Endler reported using an acrylic material to replace the base of the proximal phalanx of the hallux. Swanson used a metallic component to replace the head of the first metatarsal. Joplin used a Vitallium head or base to replace the first metatarsophalangeal joint during the 1960s. Seeburger, a podiatrist, reported in 1965 on the use of a Durillium component to replace the metatarsal head.

In the late 60s, and through the 70s and 80s, Silastic material has been widely used to replace pedal joints. A higher density Silastic was developed in 1974 to replace the softer material originally used. A variety of shapes and sizes of Silastic implants were used for the various joints in the foot. A Dacron mesh was incorporated in some of these implants to help promote tissue ingrowth and attachment to surrounding tissues. Recently metallic grommets are being used to protect some silicone implants. Two component systems of titanium or cobalt metal and polyethylene material were introduced in 1976 and again in 1981, but have fallen into disrepute. Two additional 2-component systems for first metatarsophalangeal joint replacement have been once again promoted in the last two years. Polyethylene is also being used as a blocking device for subtalar joint arthroereisis procedures.

Complications and failures have occurred with most of these implants. The biomaterials themselves have limitations. Dynamic biomechanical forces must be neutralized to allow any hope of success. The implants themselves are basically space fillers and can not be used to resist strong repetitive deforming forces. This is especially true when reactive forces of weightbearing are oblique to the long axes of bone. Furthermore, the biomaterial-organic material interface has been an area of compromise.

TISSUE REACTIVITY TO BIOMATERIALS

Most of the materials currently used react very minimally with surrounding tissue structures. However, the Dacron mesh, used in the 60s and 70s with pedal implants proved to be highly reactive and has fallen into disrepute. The lower density Silastic deformed too readily for pedal implants. The higher density Silastic is more resistant to deformation, although it cannot resist strong deforming forces. The metal implants utilized in the foot for the most part have been found to be too hard. The new 2-component first metatarsophalangeal joint units—the Koenig system and the Biomet system remain to be proven as an exception.

METATARSAL HEAD REPLACEMENTS

Implantable materials that replaced metatarsal heads, both metal and Silastic, generally failed. The dynamic forces of weightbearing are oblique to the shaft of the metatarsals. Therefore, these implants invariably loosen and sublux dorsally. (Fig. 2). Furthermore, since the implants are not capable of bearing weight for any length of time, the remaining metatarsal heads must take on additional loads that commonly result in symptoms under adjacent metatarsal heads.

Fig. 2. Dislocated metatarsal head replacement.

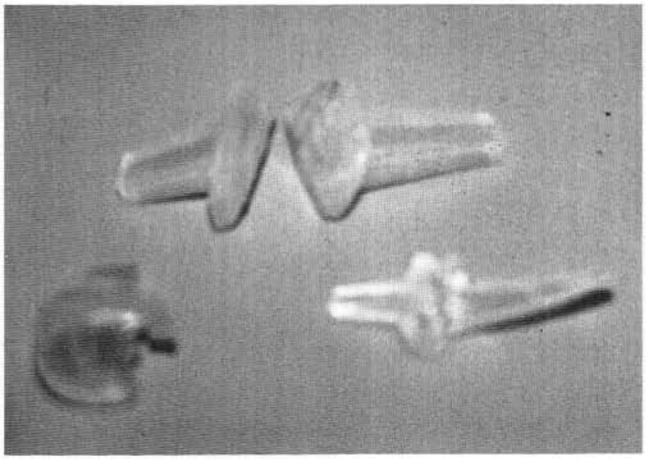

Fig. 3. Deformed, fractured, and worn Silastic implants.

NEUTRALIZATION OF DEFORMING FORCES

If deforming forces are not neutralized around the joint, the biomaterial will deform or the organic housing material for the implant will wear and remodel to allow displacement. Inorganic material cannot sustain itself in its original form in the face of ongoing significant deforming forces. (Fig. 3). Bone is a dynamic organic material and will adapt or accommodate to deforming forces, even to the point of allowing dislocation through the wall of the bone itself, if the force is severe enough. Vanore indicated that Silastic failure may be more rapid if inadequate bone was resected, if the implant was placed eccentrically, or if the deforming forces were not adequately neutralized.

HEMI IMPLANTS

When half of the joint is replaced, the gliding biomaterial-organic material interface becomes a major concern. In the foot, this generally means replacement of the base of the proximal phalanx. Metal is a hard unforgiving material that will eventually wear out the cartilage on the opposite side of the joint. Silastic is a softer material but it may be abraded on an irregular cartilaginous interface leading to sharding. Furthermore, the material can implode into the head of the metatarsal leading to cystic degeneration of the metatarsal head. Silastic can also be cut in large pieces by irregular surfaces of bone. The Silastic can deform, thin, and fracture. There have been reported cases of silicone migration with positive lymphatic nodular biopsies.

Recently, Dow-Corning has come out with a titanium hemi implant to help avoid the silicone complications. However, titanium is a hard metal material and subject to the complications noted above.

Further considerations of the hemi implants relates to the structural stability around the metatarsophalangeal joint. For the lesser metatarsophalangeal joints, the hemi has proven difficult to use due to the loss of intrinsic musculature when removing the base of the proximal phalanx. Soft tissue techniques around the first metatarsophalangeal joint designed to lengthen the extensor hallucis longus and resuture the flexor hallucis longus or the flexor hallucis brevis tendons have helped to reduce the postoperative deforming forces across this joint. Furthermore, resection of more bone in order to relax the structures across the joint seems to slow the rapidity of the Silastic degeneration.

THE TOTAL METATARSOPHALANGEAL JOINT

The Silastic hinge total metatarsophalangeal joint replacements seemed to be advantageous over the hemi implant as they avoid the biomaterial-organic cartilage interface. The hinged implant-

Fig. 4. Overgrowth of bone around a total implant.

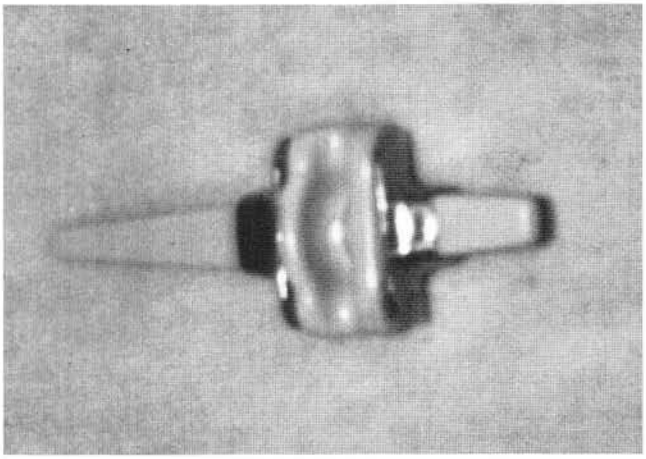

Fig. 5. Grommets used with a Silastic implant.

stem of the proximal phalanx or metatarsal interface can still lead to some sharding but this has not been as significant a problem as with the hemi implant. Over growth of the raw bony surfaces over the implant can prove to be a problem. (Fig. 4). Metal grommet sleeves have recently been introduced in an attempt to decrease the sharding and overgrowth of bone at the Silastic-bone interface (Fig. 5).

Of course, these hinged implants do not allow normal function across the metatarsophalangeal joint. These joints usually have a gliding component to the motion and are not pure hinge joints like the implants are. Intrinsic stability is lost when the base of the proximal phalanx is sacrificed. Balance must be re-established in order to neutralize deforming forces. The most significant difficulty in creating neutralization of these forces is seen in the lesser metatarsophalangeal joints when the base of the proximal phalanx is sacrificed. Jim Ganley suggests transferring the extensor digitorum longus to the metatarsal shaft when the proximal phalangeal base is removed. This may prove helpful in total joint replacement of the lesser metatarsophalangeal joint.

CAPPING IMPLANTS

Both silastic and metal capping implants have been used in the metatarsal head replacement procedures. This type of device has been used to replace proximal phalangeal heads. The theory behind this design suggested that the encapsulating fit of the implant around the end of the bone would help to prevent dislocation, prevent overgrowth of bone, and help to prevent sharding in the Silastic implants. In fact, these implants appear to restrict blood supply from the surrounding soft tissues to the bone. Failures were related not only to the oblique dislocation forces at the metatarsal head, but also from weakening of the bone due to restricted blood supply at the metatarsal stump.

DIGITAL IMPLANTS

Digital implants have been used to replace proximal interphalangeal joints. Hinged total implants did not provide stability across the joint. Solid total Silastic joints seem to have held up much better. (Fig. 6) The question arises as to the necessity of using an implant at all in the lesser digit. Sollito and Warner in 1983 did not find any benefit from digital implantation as compared to the more traditional arthroplasty or arthrodesis in their study. Perhaps the implant may be helpful in establishing length and stability in the postoperative complication of a flail digit.

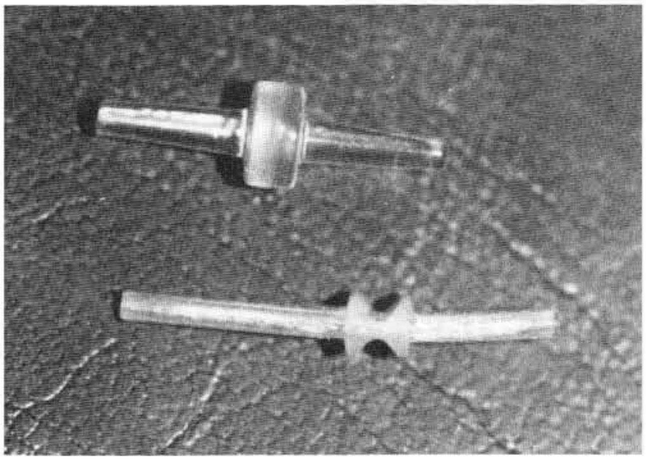

Fig. 6. Digital implants, hinged and solid.

ARTHROEREISIS

A number of different materials have been utilized in the sinus tarsi in an attempt to block excessive pronation. Polyethylene seems to be the most effective material being used at the present time. Smith's STAPEG is FDA-approved and is either placed perpendicular to the ground or perpendicular to the leading wall of the posterior facet of the talus. (Fig. 7A, 7B). Valenti's polyethylene threaded cylinder has also been reported as providing good results. Silastic blocking materials such as the hemi implant and Sgarlatto's STA-Plug do not seem to hold up well to the significant forces that occur in this area. Recently, Allen Jacob reported one case where MRI studies revealed asymptomatic cysts in the talus of a patient that was long term postoperative following STA-Peg implantation. Long term follow up studies are important when evaluating implant successes and failures. Removal of these implants may prove efficacious in the long run once bony adaptation has been accomplished.

The ideal implant has not yet been found. Wear surface ceramics and biodegradable fixation devices are areas being explored by the researchers. Implants have their limitations and potential long-term complications. Many times they can be used as temporary spacers and removed before the long-term complications can occur. Jim Ganley doesn't like to use implants if they can be avoided. Guido LaPorta is no longer using the total first metatarsophalangeal joint implant that bears his name.

Long term follow up studies are necessary. Complications can occur. The implants may require removal. Alternatives to implantable joint replacements should be explained to patients. When performing implant procedures, neutralization of the deforming forces must be sought, adequate bone must be resected, and adequate surround soft tissue must be available and preserved.

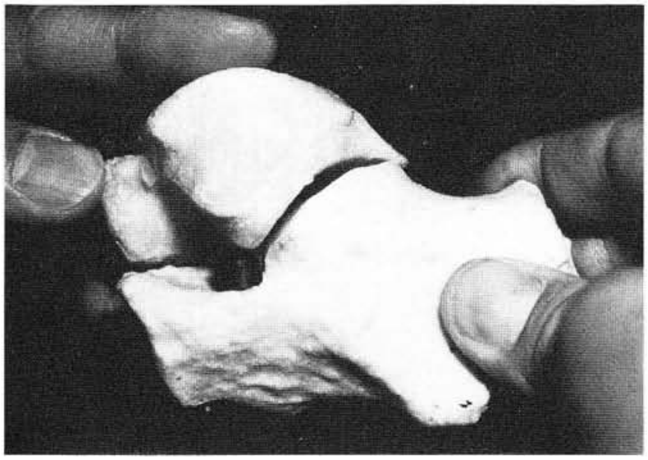

Fig. 7A. STA-PEG placed perpendicular to the ground allowing blocking by having the posterior facet of the talus ride up on the implant.

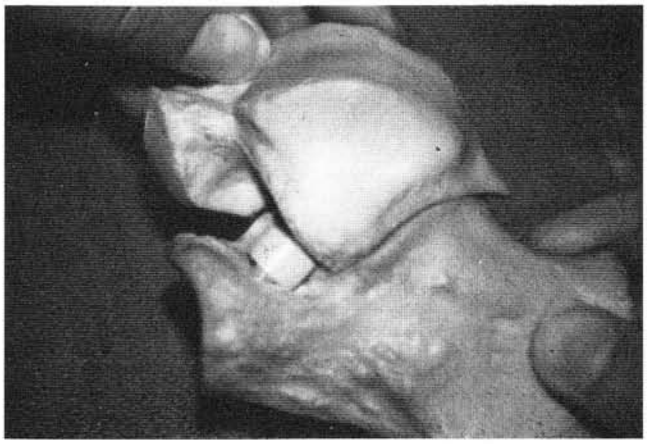

Fig. 7B. STA-PEG perpendicular to the leading wall of the talus blocking adduction forward progression of the lateral wall of the talus.