SWANSON flexible FINGER JOINT IMPLANT

surgical technique

surgical technique presented by
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specific PRECAUTIONS

Fitting of the grommet requires a precise press-fit. It must be accurately centered, otherwise it may impinge the cortex in the intramedullary canal on one side and could cause bone resorption. Unless the shoulders of the grommet can be fitted into metaphyseal bone, rotation of the grommet could occur. In certain cases of severe metacarpophalangeal joint dislocation, additional bone must be removed to obtain joint reduction and the implant may have to be used without the grommet.

general PRECAUTIONS

The potential for complications or adverse reactions with any implant can be minimized by following the instructions for use provided in product literature.

It is the responsibility of each surgeon using implants to consider the clinical and medical status of each patient and to be knowledgeable about all aspects of implant procedure and the potential complications that may occur. The benefits derived from implant surgery may not meet the patient’s expectations or may deteriorate with time, necessitating revision surgery to replace the implant or to carry out alternative procedures. Revision surgeries with implants are common. The patient’s mental status must also be considered. Willingness and/or ability to follow postoperative instructions may also impact the surgical outcome. Surgeons must balance many considerations to achieve the best result in individual patients.

IF EXCESSIVE LOADING CANNOT BE PREVENTED, AN IMPLANT SHOULD NOT BE USED.
One of the goals of implant surgery is to minimize production of wear particles. It can never be eliminated because all moving parts e.g., implants which articulate against bone wear to some degree. In an implant arthroplasty, clinically significant wear can result from normal biomechanical forces. Abnormal or excessive force will further increase clinically significant wear.

Abnormal force loading may be caused by:
· Uncorrected instability
· Oversized implant
· Inadequate soft tissue support
· Implant malposition
· Excessive motion
· Uncorrected or recurrent deformity
· Patient misuse or overactivity
· Intraoperative fixation

Some preventive measures to consider to minimize the potential for complications:
· Follow guidelines for indications and contraindications provided above
· Identify prior pathology
· Stabilize collapse deformities
· Bone grafting of cysts
· Use a properly sized implant
· Avoid K-wires and sutures through the implant

If complications develop, possible corrective procedures include:
· Implant removal
· Synovectomy
· Bone grafting of cysts
· Limited intercarpal fusion
· Replacement of the implant
· Removal of the implant with fusion of the joint

Clinical results depend on surgeon and technique, preoperative and postoperative care, the implant, patient pathology and daily activity. It is important that surgeons obtain appropriate informed consent and discuss the potential for complications with each patient prior to surgery. This may include a review of alternative, non-implant procedures such as soft tissue reconstruction or arthrodesis.
POTENTIAL COMPLICATIONS AND ADVERSE REACTIONS

In any surgical procedure, the potential for complications exists. The risks and complications with the Swanson Finger Joint Implant and the Swanson Finger Joint Grommet include:

- Infection or painful, swollen or inflamed implant site
- Fracture of the grommet, the implant stem and/or the hinge
- Loosening or dislocation of the prosthesis requiring revision surgery
- Bone restoration or over-production
- Allergic reaction(s) to prosthesis material(s)
- Untoward histological responses possibly involving macrophages and/or fibroblasts
- Migration of particle wear debris possibly resulting in a bodily response

Some degree of particle formation is inevitable with all implants including those made of silicone elastomer. The amount will vary with factors such as patient activity, metacarpal stability or instability post-implantation, implant position and the amount of soft tissue support.

The patient's biological response to these particles is variable, but can include local synovitis and bone lysis in contiguous bones. Another potential concern with silicone implants arises from case reports in the literature suggesting an association between silicone implants and immunological abnormalities and autoimmune rheumatic disorders, although these reports have been contradicted and the association has not been proven conclusively.

RISK/BENEFIT DECISION BY SURGEON

The judgement by a surgeon to implant silicone elastomer implants is a complicated risk/benefit decision which must take into account the patient's needs and desire in addition to the surgeon's knowledge of expected results and complications as well as therapeutic alternatives. Wright Medical Technology, Inc. can provide a bibliography of articles on the use and complications of silicone elastomer implants to any physician.
device DESCRIPTIONS

FLEXIBLE IMPLANT
The Swanson Finger Joint Implant* is a flexible intramedullary-stemmed, one-piece implant developed as an adjunct to resection arthroplasty to help restore function to hands disabled by rheumatoid, degenerative or traumatic arthritis. It is made from silicone elastomer, a material that is highly resistant to flexion-fatigue induced flaw-propagation. The midsection of the load-distributing flexible hinge has been designed to help maintain proper joint space and alignment with good lateral stability and minimal flexion-extension restriction. The implant is not fixed to bone and becomes stabilized by the encapsulation process. It acts as a dynamic spacer, internal mold and flexible hinge. The Swanson Finger Joint Implant is available in 11 sizes to adequately meet various anatomical requirements. A color-coded sizing set (supplied non-sterile and not suitable for implantation) is available for proper size determination during surgery.

GROMMETS
The Swanson Finger Joint Grommets** are thin bone liners designed for use at the metacarpophalangeal joint level to protect the flexible implant midsection from the shearing forces of sharp bone edges. The press-fit encircling grommet is fabricated from unalloyed titanium and its shape conforms to the contours of the implant midsection and stem junctions.

The use of grommets to enhance implant durability is especially indicated in severe cases of rheumatoid arthritis where irregular and sharp bony edges can initiate tears in the implant midsection.

Grommets are available in 7 sizes corresponding to sizes 3 to 9 of the Swanson Finger Joint Implant. The outer surface of each grommet is marked with a numeral, indicating the size of finger joint implant the grommet fits, as well as the letters "P" or "D", indicating whether it is a proximal or distal grommet.

*U.S. Patent No. 3,875,594f
**U.S. Patent Nos. 4,158,893; 4,198,713
rationale

**FLEXIBLE IMPLANT**

The Swanson Finger Joint implant can be used with resection arthroplasty of the metacarpophalangeal (MP), proximal interphalangal (PIP) and distal interphalangeal (DIP) joints. Insertion of the finger joint implant at two consecutive joint levels is not recommended (e.g., MP and PIP joint levels).

The flexible implant resection arthroplasty method is based on the following concept: "Joint Resection + Implant + Encapsulation = Functional Joint."

The implant acts as a dynamic spacer to maintain internal alignment and spacing of the reconstructed joint and as an internal mold that supports the capsuloligamentous system developing around the implant while early guided motion is started. The implant becomes stabilized by this "encapsulation process," and no permanent fixation is required. Joint stability is achieved from reconstruction of the ligamentous and musculotendinous systems.

Because the implant is not fixed to bone, the compressive loading forces are effectively distributed to the resected end of the bone and cortical shaft. This encourages favorable bone remodeling processes as evidenced by maintenance of bone length, preserved shape of the amputated bone end, cortical thickening, and new bone formation next to the implant midsection and intramedullary stems.

The slight movement of the implant stems allows distribution of forces over a broader section and allows the flexible hinge to find a better position with respect to the axis of rotation of the joint. Thus the implant life is increased and the bone is less likely to react at the implant interface when the forces are within its strain tolerance. The low modulus implant is softer than bone and has force-dampening characteristics that further protect bone and cortical shaft.

Because bone removal is minimal and implants are not attached to bone, revision procedures to remove or replace an implant, or to reinforce, release, or realign capsuloligamentous structures around the implant are easily performed.
GROMMETS
The unattached, press-fit grommets effectively protect the implant midsection by lessening abrasion, wear and cutting by bone. Because the grommet is not attached to bone, compressive loading forces are transmitted to the resected bone-end and a favorable bone response develops at the grommet/bone interface. Use of encircling grommets does not alter the function of the implant, patient indications and contraindications, nor reduce the need for careful attention to the arthroplasty technique.

SPECFIC ADVANTAGES OF THE IMPLANTS
· Both elastomer and unalloyed titanium implants have an extensive clinical history of biocompatibility.
· The Swanson Finger Joint Implant and Swanson Finger Joint Grommets have been sterilized.
· Anatomical sizing (length, height, width) is available in eleven sizes to meet various operative requirements.
· Swanson Finger Joint Grommets are durable and abrasion-resistant to protect the implant from sharp bone edges.
· Pliable medical grade silicone elastomer with low elastic modulus (softer than bone) dampens force loading and minimizes potential for necrosis or bone resorption. Cortical bone density typically increases postoperatively. These benefits are retained with grommet-modified implants.
· Neither flexible implants nor grommets require fixation to bone. Intramedullary gliding decreases stress to bone and implant; it allows implant to locate axis of rotation of the joint.
· Both the flexible implant and grommets are visible on x-rays.
· Design characteristics of load-distributing flexible hinges include: intramedullary-stemmed, flexible one-piece hinge-like construction of homogeneous material with stiffness/flexibility balance of implant material, and proper compression-tension force distribution in midsection.
clinical ADVANTAGES

- Improves range of motion (especially extension)
- Adequate lateral stability
- Good pain relief
- Maintains joint space and alignment
- Orient and supports joint encapsulation
- Favorable bone remodeling at implant interface; protects against bone resorption and stimulates new bone production
- Makes results more predictable, reproducible, and durable
- Early postoperative motion
- Facilitates postoperative rehabilitation
- Essentially salvageable procedure

general INDICATIONS

Any joint implant arthroplasty requires consideration of the following general indications:

- Good condition of the patient
- Good neurovascular status
- Adequate skin coverage
- Possibility of a functional musculotendinous system
- Adequate bone stock to receive implant
- Availability of postoperative therapy
- Cooperative patient

general CONTRAINDICATIONS

- Infection
- Physiologically or psychologically inadequate patient
- Inadequate skin, bone or neurovascular status
- Irreparable tendon system
- Possibility for conservative treatment
- Growing patients with open epiphyses
- Patients with high levels of activity

Each patient must be evaluated by the surgeon to determine the risk/benefit relationship.
GROMMETS
To prevent cutting and abrasion of the flexible implant by sharp bone edges in metacarpophalangeal joint reconstruction.
Grommets should not be used if:
1. A perfect press-fit cannot be obtained into metaphyseal bone (resection done at diaphyseal level).
2. During surgery, there appears to be a tendency for dorsal protrusion. This can occur at the level of the index and little fingers.
3. There are severe bone absorption problems as seen in arthritis mutilans. These cases are best treated with joint fusion or with silicone implant arthroplasty without the use of grommets.
4. Bone destruction does not allow a good fit and occasionally in the 5th MP joint.
5. Grommets are not recommended for use in the proximal interphalangeal joint.

SURGICAL STAGING
Excessive manual labor and awkward weight bearing on hand(s) such as occasionally occurs in some crutch walkers should be avoided after upper extremity reconstruction. If crutches are absolutely necessary, platform crutches should be used. Lower extremity reconstructive surgery should be carried out first if feasible. Multiple reconstructive procedures must be appropriately staged. In metacarpophalangeal joint disabilities with severe wrist involvement, the wrist should be treated first. Tendon repair and synovectomy of tendon sheaths should be done 6 to 8 weeks before joint reconstruction in the rheumatoid hand. However, if the extensor tendons are ruptured and the metacarpophalangeal joints are dislocated, arthroplasty of the metacarpophalangeal joints is done before the wrist and tendon reconstruction. In swan-neck deformity, surgery of the metacarpophalangeal and proximal interphalangeal joints is done at the same stage. However, in boutonniere deformity, it may be preferable to reconstruct the proximal interphalangeal joint before the metacarpophalangeal joint. Based on a long-term experience, a system for classification of treatment for combined involvement of the metacarpophalangeal and interphalangeal joints has been devised by Swanson | TABLES I, II, III.

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# TREATMENT OF INTERPHALANGEAL DISABILITIES WITH OR WITHOUT METACARPOPHALANGEAL JOINT INVOLVEMENT

## TABLE I - Swan-Neck Deformity of PIP Joint without Involvement of MP Joint

| 1. Initial deformity of PIP Joint | a. Local injections (corticosteroids or other agents)  
b. Flexor-tendon synovectomy with or without tenodesis of flexor digitorum superficialis tendon  
c. Intrinsic tendon release with or without flexor-tendon synovectomy |
| 2. Flexible deformity of PIP Joint | a. Dermadesis at PIP joint  
b. Relocation of lateral tendons with or without elongation of central tendon  
c. Tenodesis of flexor digitorum superficialis tendon with flexor synovectomy |
| 3. Rigid, subluxated or dislocated PIP joint | a. Resection of joint with relocation of lateral tendons and implant arthroplasty (rarely)  
b. Resection of joint and fusion |
| 4. Treatment for DIP joint, when required in any of these conditions | a. Temporary pinning in neutral position, if passively correctable  
b. Fusion, if severely damaged or flexed |

## Swan-Neck Deformity of PIP Joint with Involvement of MP Joint

<table>
<thead>
<tr>
<th>Treatment of MP Joint</th>
<th>Treatment of PIP Joint</th>
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| 1. Flexible deformity of PIP joint | a. Synovectomy with proximal release of intrinsic tendons  
b. Relocation of subluxated joint with proximal release of intrinsic tendons  
c. Joint resection with proximal release of intrinsic tendons and implant arthroplasty |
| 2. Rigid, subluxated or dislocated PIP joint | a. Joint resection with implant arthroplasty  
b. Relocation of lateral tendons with elongation of central tendon  
c. Joint resection with implant arthroplasty (rarely) |
| 3. Treatment of DIP joint, if required in any of these conditions | a. Temporary pinning in neutral position, if passively correctable  
b. Fusion, if flexion deformity is severe or articular damage exists |

## TABLE II - Boutonniere Deformity of PIP Joint

| 1. Initial deformity of PIP joint | a. Local injections (corticosteroids or other agents) or splinting  
b. Synovectomy |
| 2. Flexible deformity of PIP joint | a. Reconstruction of central tendon  
b. Elongation of lateral tendons  
c. Combination of procedures a & b, with or without synovectomy |
| 3. Rigid, deformity of PIP joint without bone erosion | a. Joint release with reconstruction of central tendon and elongation of lateral tendons  
b. Joint resection with reconstruction of tendons, with or without implant arthroplasty  
c. Distal release of lateral tendons |
| with bone erosion | a. Joint resection with reconstruction of central tendon and lateral tendons, with implant arthroplasty  
b. Joint resection and fusion |
| 4. Subluxated or dislocated PIP joint | a. Joint resection with reconstruction of central tendon and lateral tendons, with implant arthroplasty  
b. Joint resection and fusion |
| 5. Treatment of DIP joint, if required in any of these conditions | a. Distal release of lateral tendons  
b. Fusion |

## TABLE II - Boutonniere Deformity of PIP Joint

| 1. Nondislocated PIP joint | a. Joint resection with implant arthroplasty |
| 2. Subluxated or dislocated PIP joint | a. Joint resection with implant arthroplasty  
b. Joint resection with fusion |
| 3. Treatment of DIP joint, if required either of these conditions | a. Fusion, if needed |
Several reconstructive procedures can be performed during one operative session. Two surgical teams can be working on the upper and lower extremities at the same time. An operation on an extremity should not exceed two hours; a stellate ganglion block is recommended if the tourniquet time should exceed 1 ½ hours. Pre-cooling of the arm with ice packs are recommended by Tajima can prolong the surgical time available.

**clinical INDICATIONS**

**METACARPOPHALANGEAL JOINT IMPLANT ARTHROPLASTY**

Painful rheumatoid or post-traumatic disabilities with:
1. Fixed or stiff MP joints.
2. X-ray evidence of joint destruction or subluxation
3. Ulnar drift, noncorrectable by surgery of soft tissues alone.
4. Contracted intrinsic and extrinsic musculature and ligament system
5. Associated stiff interphalangeal joints.

**INCISION AND EXPOSURE**

A transverse skin incision is made on the dorsum of the hand over the necks of the metacarpals. The dissection is carried down through subcutaneous tissue to expose the extensor tendons. The dorsal veins, which lie between the metacarpal heads are carefully released by blunt longitudinal dissection and are retracted laterally. The extensor hood is exposed to the base of the proximal phalanx. Its radial portion is usually stretched out and the extensor tendon dislocated ulnarward. In the index finger, the incision is made between the extensor digitorum communis and the indicis proprius tendons. In the middle and ring fingers, a longitudinal incision is made in the extensor hood parallel to the extensor tendon on its ulnar aspect. In the little finger, the approach is made between the extensor communis and proprius tendons. The hood fibers and capsule are carefully dissected from the underlying synovium and retracted to the radial side. The joint is exposed and the head of the metacarpal is identified.

**RESECTION OF METACARPAL HEAD**

The neck of the metacarpal is exposed subperiosteally and cleanly transected with an air drill or motor saw, leaving part of the metaphyseal flare. Care should be taken to avoid splintering the bone. The head of the metacarpal is grasped and removed along with the hypertrophied synovial material. A pituitary rongeur has been found to be useful to remove further involved synovia of the joint cavity and surrounding tissues.
SOFT TISSUE RELEASE

A comprehensive soft tissue release procedure must be done at this stage to allow the base of the proximal phalanx to be loose enough to be displaced dorsally above the metacarpal. The ulnar collateral ligament is released from its phalangeal insertion in all fingers; if severely contracted, it can be excised along with a palmar plate when necessary.

At the level of all fingers, the radial collateral ligament insertions are preserved whenever possible. If it is necessary to detach this ligament, it should be reattached to the metacarpal or the base of the proximal phalanx. The important repair technique of this ligament will be described later.

The ulnar intrinsic tendon is identified, pulled up into the wound with a blunt hook, and sectioned at the myotendinous junction if tight. However, the ulnar intrinsic of the index (first volar interosseous) normally applies a supinatory force to this digit and should be preserved to help avoid a postoperative pronation deformity tendency.

In some patients who have demonstrated evidence of a flexor synovitis, the flexor sheath can be incised longitudinally in its dorsal aspect. The long flexor tendons can be identified and pulled up gently into the wound with a blunt hook. The degree of involvement of the flexor tendons can be evaluated. In some cases, a partial synovectomy and tendon sheath release or an injection of corticosteroids is done through this incision.

The tendon of the abductor digiti minimi is exposed on the ulnar aspect of the fifth metacarpophalangeal joint, pulled into the wound with a blunt hook, and sectioned. Care should be taken to avoid the ulnar tendon eventually reattaches, but in a lengthened position. The tendon of the flexor digiti minimi is preserved because of its importance to obtain flexion at the metacarpophalangeal joint of the little finger. Furthermore, it is not an important ulnar deviator.
BONE RESECTION AND PREPARATION

The base of the proximal phalanx is resected including marginal osteophytes which might interfere with the implant. All cartilage is removed from the base of the proximal phalanx because it is believed that progressive cartilage degeneration can eventually result in recurrent synovitis.

The intramedullary canal of the metacarpal is prepared in a rectangular fashion with a rasp, curet, broach, and air drill with a special bur. These burs have a smooth leader point, which helps keep them in the canal and prevents inadvertent perforation through the cortex. The occasional construction in the intramedullary canal of the proximal third of the metacarpal can be enlarged with the bur. The intramedullary canal of the ring metacarpal is frequently quite small and requires careful preparation. Care should be taken to avoid too much reaming of the canals, especially in patients with thin bones.

A trial fit is made with the appropriate color coded sizers. The implant stem should fit well down into the canal so that the transverse midsection of the implant abuts against the bone end. The end of the implant stem must not abut the end of the intramedullary canal and the stem must be appropriately shortened. The largest implant possible should be used. Implants of sizes 4 through 9 are generally used.

A rectangular hole is then made in the base of the proximal phalanx with an osteotome, knife, broach, or air drill. The intramedullary canal is reamed in the same fashion as the metacarpal to receive the distal stem of the implant selected for the metacarpal.

**FIGURE 1** | Any sharp points or rough surfaces on the bone ends should be made completely smooth. Using the color coded sizers, proper fit of the implant is verified. With the joint extension, there should be no impingement of its midsection. If there is, soft tissue release or bone resection has not been adequate | **FIGURE 2**.
In the index and middle fingers, the intramedullary canal is reamed in a rectangular shape, which is positioned high on the dorsal ulnar side of the base of the proximal phalanx and low on its radial palmar side. This proper rectangular and axial configuration of the canal stabilizes the implant stems and helps maintain a slight supination of the digit to prevent postoperative pronation deformity. Contrarily, in the little finger, a position of slight pronation is desired and the intramedullary rectangle is positioned high on the dorsoradial side and low on the ulnar palmar side.

In patients selected to receive Swanson grommets, the implant sizer is removed and the bone canals are prepared to allow a press-fit of the appropriate sized grommet. The resected surfaces of the metacarpal and proximal phalanx are shaped to obtain a precise fit of the grommet sleeve and of its slightly curvilinear flanges against the resected bone ends so that contact with overlying soft tissues is avoided. Both surfaces are prepared and smoothened with a diamond bur or other appropriate fine burs.

**CAUTION** | Fitting of the grommet requires a precise press fit. It must be accurately centered, otherwise it may impinge the intramedullary canal on one side and cause bone absorption. Unless the shoulders of the grommet can be fitted into metaphyseal bone, rotation of the grommet could occur. In certain cases of severe metacarpophalangeal joint dislocation, more bone must be removed to obtain joint reduction and the implant should probably be used without the grommet. Occasionally, grommets are not used in the 5th MP joint and should not be used in arthritis mutilans.

The grommet size corresponds to the implant size | **FIGURE 3**. The fitting must be exact with regard to centering and rotation. Minimal additional bone shaping is usually needed. Trial seating of the grommet is done by gentle pressure with the Grommet Seater or a flat instrument held against the exposed surface of the grommet with care to avoid bending or distorting the grommet. The grommet shoulders are seated directly against resected bone and must not protrude. If too loose, the next larger size is selected. When necessary, using a grommet one size larger than the flexible implant is permissible but a grommet smaller than the implant is never used. The implant/grommet fitting should be observed in flexion and extension.
The implant must slide into the grommet and not be impinged by a too narrow joint space or an uncorrected palmar subluxation. The principal of the flexible hinge as a joint spacer must be respected | FIGURE 2. The grommets and sizing unit are removed to carry out soft tissue reconstruction.

SOFT TISSUE RECONSTRUCTION

Soft tissue reconstruction is a critical step of the operative procedure. Proper balance of all the following structures must be attained: collateral ligaments, palmar plate, capsule, intrinsic tendons, flexor, and extensor mechanism.

Rheumatoid patients often present an inadequate first dorsal interosseous muscle or have a tendency for pronation deformity of the index finger and occasionally the middle finger, which can interfere with the pinch and grasp mechanism.

Reconstruction of the radial collateral ligament is important to correct the lateral and rotatory alignment and to improve lateral stability for pinch. The goal of the procedure is to place the index and middle fingers in a position of slight supination and abduction. This procedure can occasionally be indicated for the ring finger. However, it is never carried out for the little finger, as it would place this digit in supination, which would interfere with flexion of the adjacent digits. A neutral position or slight pronation is preferred.

Reefing of the preserved radial collateral ligament of the index, middle, and occasionally, ring fingers, is done by passing a 3-0 Dacron suture through a 0.5mm drill hole made in the dorsal radial side of the cut end of the metacarpal. The radial collateral ligament can require reattachment to bone proximally (metacarpal) or distally (base of proximal phalanx) or to both areas according to how much bone has been removed. The radial capsule, which has been preserved, is also included in this repair | FIGURE 4.
An additional small drill hole can be made in the dorsal ulnar side of the cut end of the metacarpal to secure the radial capsule with a 4-0 Dexon suture. However it is preferred to suture the ulnar edge of the capsule to the ulnar collateral ligament to bring the repaired capsule well ulnarward over the joint. The sutures are placed before the implant is inserted and are tied as the finger is held in slight supination and abduction. Note that the first dorsal interosseous muscle fibers become dorsally relocated with this repair.

This procedure has seemed to be important in correction of pronation deformities and provides some improved lateral stability for pinch. It seems to decrease flexion of the index metacarpophalangeal joint by 10° to 20° by tightening the capsule, but this loss is outweighed by increased stability and a better correction of the pronation deformity.

If the radial collateral ligament has been released from the base of the proximal phalanx it should be reattached in a manner similar to that described above. If the radial collateral ligament is inadequate, a portion of the palmar plate is used to reconstruct this ligament. A distally-based flap made of the medial half of the palmar plate is prepared and sutured in position through a drill hole made in the dorsoradial aspect of the cut end of the metacarpal, similarly as described above.

Meticulous evaluation and correction of the balance of the capsuloligamentous and musculotendinous structures will be rewarded by improved results.

**IMPLANT INSERTION**

The wound is thoroughly irrigated with triple antibiotic solution. The proximal grommet is press-fit into the metacarpal and the distal grommet into the proximal phalanx following the procedure described for trial insertion. Both grommets are firmly seated against the resected bone by gentle pressure, taking care of avoid deforming the grommet. The flexible implant is then inserted using blunt instruments and a "no-touch" technique. First, the implant is inserted into the intramedullary canal of the metacarpal, and then, by slight traction on the finger, the joint is distracted and the implant is flexed so that the distal stem can easily be inserted into the proximal phalanx. With the joint in extension, there should be no impingement of the implant. If there is, soft tissue release or bone resection has been inadequate.

**NOTE** | Handling of the implant should be done with blunt instruments to avoid surface trauma or contamination with foreign bodies. Reshaping of the implant should be avoided because it can compromise or destroy the functional integrity and the functionality of the implant.
EXTENSOR HOOD REEFING
The radial portion of the sagittal fibers of each extensor hood mechanism is reefed in an overlapping fashion so that the extensor tendon is brought slightly to the radial side of the center of the joint. Three to five 4-0 Dexon sutures with a buried-knot technique are used. In the index and middle fingers, it is most important not to over-correct the position of the extensor tendon too far radially to avoid deforming forces in favor of pronation. In certain cases of severe or long-standing flexion deformity, the extensor tendons may become stretched, and an extensor tendon lag may persist if not corrected. In these cases, the extensor tendon should be reefed not only transversely as described, but also longitudinally. Occasionally, the extensor tendon is tenodesed to the dorsal base of the proximal phalanx through small drill holes. Perfect balance of the extensor mechanism is essential. The juncturae tendinae which have been divided during the release of the extensor tendons are meticulously re-approximated with 4-0 Dexon sutures using inverted knots. This is done to further balance the extensor mechanism and provide all possible extensor power.

CLOSURE AND DRESSING
The skin incision is closed with interrupted 5-0 nylon sutures; for small incision drains are inserted into the wound subcutaneously. A non-adherent dressing, such as rayon, is applied over the wound along with a Betadine or alternate gauze overlay. A voluminous hand-conforming dressing is applied, avoiding pressure on the radial side of the index. Gauze is placed between the fingers, but not down into the clefts which might cause vascular constriction. A roll of Dacron batting is placed longitudinally across the dorsal and palmar aspect of the forearm, wrist, hand, and fingers. Sheet wadding or Webril is then applied. A narrow plaster or wooden splint is applied to the palmer aspect, and the entire dressing is wrapped in a conforming bandage, such as Kling.

POSTOPERATIVE CARE AND BRACING
The ideal motion would provide adequate flexion of the ulnar digits, allowing the surface of their pulps to touch the palm at the distal palmar crease for adequate grasp of smaller objects. Full flexion of the index and middle fingers is less critical for grasping, as these digits are mainly used for pinch activities. A degree of spreading of the finger, is important. Full extension at these joints is also important to perform normal hand activities and to maintain the balance of the distal joints. Chronic flexion deformity of the metacarpophalangeal joints can further aggravate hyperextension tendencies at the proximal interphalangeal joints. Pronation deformity of the index finger and, occasionally, the middle finger can be a problem in the rheumatoid hand and can, to some degree, be corrected in the postoperative program.
Immediate and continuous elevation of the hand and forearm during the postoperative course is very important. The wound is usually checked on the second day and drains removed. If swelling is minimal, use of the dynamic brace can begin on the third to fifth postoperative day. A light dressing is applied to the hand and forearm, and the dynamic brace is fitted and adjusted, enabling the patient to start finger movements in a protected arc. A ¼” felt pad is placed between the forearm and the brace. If the splint is not available, guided early motion may be obtained by applying a lightweight short arm case fitted with outriggers and similar rubber band slings.

The rubber band slings are placed on the proximal phalanges to guide the alignment of the digits into a slight radial direction to prevent recurrent ulnar drift | FIGURE 5. The tension of the rubber bands should be tight enough to support the digits and yet loose enough to allow 70° of active flexion. This is especially true of the little finger which may have weak flexion power. The brace may require adjustment once or twice a day in the early postoperative course. Joint motion is measured with a goniometer and recorded.

The thumb outrigger is applied in cases where the patient demonstrates the tendency to bring the thumb over to the fingers on flexion. This movement should be avoided because the pressure applied by the thumb to the index finger would be in the ulnar direction, thus aggravating the tendency toward ulnar drift deformity.

If there is a tendency toward medial rotation (pronation) of the metacarpophalangeal joint of the index or middle fingers, additional outrigger bars are applied to provide a supinatory force to the joint | FIGURE 5.

The extension portion of the brace is worn continuously day and night for the first three weeks, alternating with specific flexion exercises. The exercises are started three days after surgery. However, if there is severe flexor weakness of the little finger with adequate extension, the extensor slings can be removed during the exercise periods.
During the second and third weeks, the extension portion of the brace is also worn continuously day and night. If there is severe flexor weakness and good extension, the extensor slings can be removed one to two hours a day to achieve greater active flexion of metacarpophalangeal joints. Patients who have normal proximal interphalangeal joints frequently will not gain the full-expected motion at the metacarpophalangeal joint after arthroplasty because they tend to flex the proximal interphalangeal joint during their exercise program and thus relatively immobilize their metacarpophalangeal joints. To gain active motion of the metacarpophalangeal joints in these patients, small padded aluminum splints are taped on the dorsum of the proximal interphalangeal joints during the exercise periods for the first three or four weeks after surgery to encourage the patient to localize all flexion forces at the metacarpophalangeal joint.

At three weeks any residual flexor weakness should be energetically treated. In the presence of adequate extension, the preferred flexion traction method consists of placing finger slings on the proximal phalanges and attaching them volarly to the loop of a special Velcro wrist strap or to that of the dynamic splint. When these flexion slings are applied the figure eight elbow strap can be used to prevent distal migration of the brace. If the distal and proximal interphalangeal joints are stable, dressmaker hooks can be glued to the fingernails with a cyanoacrylate adhesive. Individual rubber bands are then attached from the loop of a special wrist strap to the nail hooks. Small band-aids can be applied over the hooks for patient comfort between exercise periods. These fraction methods give better control of alignment and the desired amount of flexion pull for each individual finger. The wearing schedule for these flexion devices varies with each patient but usually should not exceed 20 minutes. If more flexion is required the number of daily applications can be increased. In most cases 2-6 times daily is sufficient.
The extension portion of the brace is usually worn at night only, starting on the fourth postoperative week, for another three weeks. In a few cases where there is a persistent extensor lag or a tendency for flexion contracture or deviation of the digits, continued part-time support by the use of the brace must be prescribed for several weeks or even months. The patient should follow a continued exercise and stretching program for three months postoperatively to maintain the movement obtained in the earlier phase. After this time the final range of motion will have been established. The patient should be instructed to avoid rough usage of his hands. He should also avoid unsupported lateral pinch and substitute with tripod, chuck, or supported lateral pinch.

The most important rehabilitation program has been thoroughly described in previous publications and should be faithfully followed to obtain the ideal result | FIGURE 6.

**clinical INDICATIONS**

**PIP JOINT IMPLANT ARTHROPLASTY**

Rheumatoid, degenerative, or post-traumatic disabilities with:

1. Destroyed or subluxated joints
2. Stiffened joints in which a soft tissue release alone would be inadequate. An implant arthroplasty of the proximal interphalangeal joint is preferred for isolated severe disability of the proximal interphalangeal joint. For disabilities of both the index and middle fingers in a working man, fusion of the proximal interphalangeal joint of the index in 20° to 40° flexion and implant arthroplasty of the proximal interphalangeal joint of the middle finger is preferred. Flexion of the proximal interphalangeal joints of the ring and little fingers is very important for grasping small objects, and function should be restored if possible.
3. Grommets are not used in PIP joints.

**INCISION**

A "C"-shaped incision is made over the dorsum of the joint so that the skin suture line does not lie directly over the tendon repair. In the little and index fingers, the incision is placed away from the presenting surface. The dorsal veins are respected. If associated flexor tendon surgery is also indicated, a mid-lateral incision or palmar incision is used. This allows accessibility to both the joint and the tendon.
EXPOSURE

The extensor mechanism is exposed by sharp and blunt dissection, avoiding injury to its surface. The central tendon is identified and incised longitudinally in a proximal fashion from its insertion at the base of the middle phalanx through the distal two-thirds of the proximal phalanx | FIGURE 7. In flexible deformities of the PIP joint, the extensor mechanism can be gently dislocated palmarward as the joint is flexed without disturbing the insertion of each half of the central tendon into the middle phalanx. However, in hypertrophic osteoarthritic joints, it may be necessary to section this attachment of the central tendon to excise bony spurs.

The tendon is later reattached to the bone with a 3-0 Dacron suture passed through a 0.5mm drill hole made in the base of the middle phalanx. If the joint is contracted, the extensor mechanism cannot be readily dislocated and therefore, the head of the proximal phalanx is first excised by cutting it transversely at the neck with an air drill and then removing it piecemeal, or it can be removed with the burring tool of the air drill. The collateral ligaments are left intact when possible. If they are incised for joint exposure, they should be reattached to bone | FIGURE 8.

JOINT RELEASE

Adequate release of the joint is essential for good results. If the joint is severely contracted, it may be released by removing bone from the proximal and middle phalanges. If this is inadequate, the palmar plate and collateral ligaments may be incised proximally or distally according to where more bone needs to be removed. When incised the collateral ligaments should be reattached with a 4-0 Dacron suture passed through a small drill hole made in the dorsal lateral aspect of the neck of the proximal phalanx and/or middle phalanx as indicated (Fig. 8).

The sutures are placed prior to implant insertion. With the implant in position, they are tied with sufficient tension to obtain lateral stability and alignment and to allow passive motion of the joint from full extension to 70° flexion. In the presence of lateral deviation or instability, the collateral ligament described above. This procedure seems to limit flexion of the proximal interphalangeal joint slightly, but can be important in cases mentioned earlier.
BONE PREPARATION
After resecting the head of the proximal phalanx at the metaphyseal flare with a power saw of a side-cutting bur, the intramedullary canal is prepared to receive the implant stem. It is first penetrated with a thin broach, then reamed into a rectangular shape with an air drill and leader point bur to accept the implant stem.

The base of the middle phalanx and intramedullary canal are prepared in a similar fashion. All cartilage is excised because it is believed that progressive cartilage degeneration can eventually result in recurrent synovitis.

IMPLANT SELECTION AND INSERTION
Using the color-coded sizing set, the largest acceptable implant is selected (size 0 through 3 and most often size 1). The midsection of the implant should seat well against the smoothened bone ends. With the joint in extension, there must be no impingement of the implant midsection by the bone ends. If this fit is not ideal, there should be additional bone resection and/or soft tissue release. If necessary, the tips of the stems can be shortened. The cut end of the stem should be 1mm shorter than the reamed canal to allow adequate gliding and prevent buckling of the implant. The joint should not flex and extend like a book would open and close; the middle phalanx should move around the end of the proximal phalanx with the center of rotation through the transverse axis of the implant midsection | FIGURE 2.

CLOSURE
Prior to the insertion of the selected implant, the required sutures for reconstruction of the ligament system and central tendon are placed through bone. Grommets are not used at this level. Following wound irrigation with triple antibiotic solution, the implant is inserted in a similar fashion as that described for the metacarpophalangeal joint.

If sectioned, the collateral ligament is firmly reattached to the proximal and/or middle phalanx using 4-0 Dacron sutures previously passed through small drill holes in the bone | FIGURE 8.

The halves of the incised central tendon are drawn together and sutured to the base of the middle phalanx with a 3-0 Dacron suture previously passed through a drill hole in the bone | FIGURE 7. The suture to the bone is especially important if the central tendon has been elongated, ruptured, or divided. Wherever possible, tendons or ligaments must be sutured to bone to obtain a firm fixation.

At the end of the procedure, adequate passive range of motion should be present, and slight traction on the joint should show an adequate joint space. The tension of the repair must be sufficient to obtain good lateral stability and alignment and to allow passive motion of the joint from full extension to 70° of flexion. If the repair is too tight there will be a noticeable droop of the distal interphalangeal joint. The most common causes of failure of extension are inadequate bone removal and soft tissue release, failure to obtain proper tension of the central slip, scar formation, and inadequate postoperative care.
The skin is re-approximated with 5-0 Nylon and small Incision Drains are inserted subcutaneously. The hand dressing is applied similarly as that described for the metacarpophalangeal joint arthroplasty.

EXTENSOR MECHANISM IN COLLAPSE DEFORMITIES
Special consideration must be given to the extensor mechanism in collapse deformities of the digits. Simply stated, in swan-neck deformity the central tendon is relatively tight as compared to the tension of the lateral tendons, and in the boutonniere deformity the central tendon is relatively loose as compared to the tension of the lateral tendons. Readjustment of the tension of these collapse deformities. It should be noted that implant arthroplasty is seldom indicated in swan-neck deformity.

BOUTONNIERE DEFORMITY
In a boutonniere deformity, the central tendon has usually been relatively lengthened, and the lateral tendons displaced palmarward with the connecting fibers stretched out. Implant arthroplasty is carried out as indicated (Table II). The stretched out attachment of the central tendon is sutured with a 4-0 Dacron suturing their connecting fibers or overlapping any redundant fibers. A residual hyperextension deformity of the distal joint can be corrected by lengthening or sectioning the lateral tendons over the middle phalanx distal to the triangular ligament.

SWAN-NECK DEFORMITY
Flexor tendon synovitis is treated before joint reconstruction. In swan-neck deformity with combined involvement of the MP and PIP joints, both joints are repaired at the same stage. Hyperextension of the PIP joint is corrected through readjustment of the joint system. The tight central tendon is lengthened, and the lateral bands are relocated palmarward. At least 10° of flexion contracture should be obtained and associated deformities of contiguous joints should be treated. In mild flexible deformity in weak hands, dermadesis of the PIP joint is indicated. In severe cases of swan-neck deformity, fusion of the joint is preferred. Implant arthroplasty is rarely indicated |TABLE 1.
The type of postoperative care varies with the preoperative deformity and the surgical reconstruction. There are three basic situations: (1) reconstruction of the stiff PIP joint, (2) reconstruction of the PIP joint with lateral deviation, (3) reconstruction of a boutonniere deformity.

**STIFF PROXIMAL INTERPHALANGEAL JOINT**

Active flexion/extension movements are started three to five days after surgery in post-traumatic cases having good soft tissue structures.

The ideal range of motion after this surgery is 0° of extension to 70° of flexion at the ring and little fingers, 60° of flexion at the middle finger, and 45° of flexion at the index finger. Small, padded aluminum splints are used to hold the finger in extension between the hourly exercise sessions. These splints are worn for at least 6 weeks postoperatively depending on the degree of extension lag present and are often worn at night for a least 3 months after surgery. The exercises are performed with a variety of exercise devices taking care of support the MP joint in extension. Resistive flexion exercises using Grip-X® (a "finger-gripper" exercise device) to support proper alignment of the digits are started 6 weeks after surgery. The DIP joint is allowed to flex freely; if necessary, it may be temporarily pinned with a K-wire to concentrate the action of the flexor profundus at the PIP joint. There are almost always a few degrees of extension lag in these types of cases.

**LATERALLY DEVIATED PROXIMAL INTERPHALANGEAL JOINT**

Implant arthroplasty of a laterally deviated PIP joint requires reconstruction of the central slip and collateral ligament(s). The soft tissue reconstruction is protected with an extension splint for a least 2 to 3 weeks. The splint can be applied slightly laterally to correct any residual deformity. Active exercises are carried out 3 to 5 times a day while wearing a protective device such as a buddy-system strap or a radial outrigger. The splint is worn between the exercise sessions for at least 6 to 8 weeks. Night splinting is continued for a least 3 to 6 months.

---

(A) Small padded aluminum splints hold digit in extension between exercise sessions. If the implant resection arthroplasty has been done to correct a boutonniere deformity, the splint should allow active flexion of the distal interphalangeal joint.

(B) The splint is applied laterally in digits that have any associated deviation.

(C) The buddy system protects digit alignment and provides a slight extension assist during active range-of-motion exercises.

(D) A radial outrigger for protecting the index digit alignment and providing a slight extension assist during active range-of-motion exercises.

* Available from ALIMED, Inc., 297 High Street, Dedham, MA 02026
BOUTONNIERE DEFORMITY

The proximal interphalangeal joint is maintained in extension with a dorsal, taped-on, padded aluminum splint. The distal joint should be allowed to flex freely | FIGURE 10. Active flexion/extension exercises are started from 2 to 3 weeks after surgery. The extension splint is worn between exercise sessions and at night for at least 6 to 8 weeks. Resistive exercises are started at 6 week. Night splinting should be continued until the joint is stable, and this may require 3 to 6 months. There is almost always a few degrees of extension lag in these cases.

ALTERNATE APPROACH

An alternate approach can be used in certain cases. The central band is preserved and the exposure is made between the lateral and central band on both sides of the joint. The collateral ligaments are released proximally on both sides of the joint to allow to dislocate the joint radially and ulnarly. The palmar plate is released proximally. Bone preparation, implant insertion and reattachment of the collateral ligaments to bone are carried out similarly as described above. The lateral bands are then sutured back to the central band. In this technique, motion of the joint can be started after 3 to 5 days because the central band has not been disturbed. It is important to protect the collateral ligaments repair from lateral deviating forces for 6 weeks. Buddy splinting can be useful. A splint is worn at night for 6 to 8 weeks and in the day as needed.

BIBLIOGRAPHY

A bibliography may be obtained by writing Wright Medical Technology, Inc. or by contacting your Wright Medical Technology, Inc. representative.

IMPORTANT POINTS TO OBSERVE

- Handling of the implant should be done with blunt instruments to avoid surface trauma or contamination with foreign bodies. Rinse the implant thoroughly with sterile saline solution before insertion.
WARNING | Reshaping of the implant should be avoided because it can compromise or destroy the structural integrity and the functionality of the implant.

- Fitting of the grommet requires a precise press fit. It must be accurately centered, otherwise it may impinge the cortex in the intramedullary canal on one side and could cause bone absorption. Unless the shoulders of the grommet can be fitted could occur. In certain cases of severe metacarpophalangeal joint dislocation, more bone must be removed to obtain joint reduction and the implant may have to be used without the grommet.
- Grommets are not used at the PIP joint level or in the presence of bone absorption or in arthritis mutilans.

HANDLING AND STERILIZATION

This product has been sterilized and should be considered sterile unless the package has been opened or damaged. Remove from package, using accepted sterile technique, only after the correct size has been determined. Always handle the product with powder-free gloves, and avoid contact with hard objects that may damage the product.

The sizing set is supplied nonsterile. The following sequential steps are recommended to clean and sterilize the sizing set or to re-sterilize the implant or grommets:

1. Scrub thoroughly with a clean, soft-bristled brush in a hot water-soap solution to remove possible surface contaminants. Use a non-oily, mild soap. Do not use synthetic detergents or oil-based soaps, as these soaps may be absorbed and subsequently leach out to cause a tissue reaction.
2. Rinse thoroughly with distilled water.
3. If using a 270°F flash sterilization cycle, place the component on a standard mesh sterilization tray.
4. If using a 250°F gravity or 270°F pulsing vacuum sterilization cycle, double wrap the component in muslin or a similar type non-woven medical grade wrapping material or place in a sealed sterilization pouch.
5. Autoclave according to the following parameters:

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After sterilization, remove the implant from its wrapping material/pouch or the sterilization tray using accepted sterile technique. Ensure that the implant is at room temperature prior to implantation.

These recommendations have been developed and tested using specific equipment. The bioburden should not exceed $10^4$ colony forming units (CFU) per equipment, it must be demonstrated that these recommendations produce sterility in your environment. If processing conditions, wrapping materials or equipment changes occur, the effectiveness of the sterilization process must be demonstrated.

Evidence suggests that repeated sterilization may affect the physical characteristics of the implant. Accordingly, resterilization in excess of three times is contraindicated.

This product is for single use only. An implant should never be sterilized after contact with body tissues or fluids.
Do **NOT** sterilize by ethylene oxide as the residual sterilant may cause adverse tissue reaction.

**CAUTION** | Federal (United States) law restricts this device to sale, distribution and use by or on the order of a physician.
HOW SUPPLIED
The Swanson Finger Joint Implant has been sterilized and packaged as follows:

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NOT FOR IMPLANTATION

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Wright Medical Technology, Inc
Swanson Finger Joint Grommet

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## TYPICAL DIMENSIONS
of Swanson Grommet on
Swanson Finger Joint Implant

Proximal Stem | Distal Stem