Review Article

JHS(E)

Journal of Hand Surgery
(European Volume)
2025, Vol. 50(2) 159–168

DOI: 10.1177/17531934241265837
journals.sagepub.com/home/jhs
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Proximal interphalangeal joint arthroplasty: current trends and evidence-based practice

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Abstract

Arthroplasty of the proximal interphalangeal joint (PIPJ) has evolved since its inception over 60 years ago. This review examines the indications for surgery, highlights the differences in current arthroplasty designs, variances in surgical techniques, clinical controversies, current implant outcomes data and salvage options for the failed implant. Overall, PIPJ implant arthroplasty is a good and reliable option for symptomatic PIPJ degenerative, post-traumatic or inflammatory arthritis given the proper clinical setting. If current techniques for implantation and rehabilitation are followed, predictable pain relief and satisfactory function can be anticipated. The purpose of this review article is to examine the current evidence-based indications for PIPJ arthroplasty and examine the reported, implant-specific outcomes of this procedure. Various techniques and rehabilitation strategies will also be outlined.

Keywords

Proximal interphalangeal joint, arthroplasty, arthritis, joint replacement

Date received: 8th January 2024; revised: 13th June 2024; accepted: 16th June 2024

Introduction

Mobile proximal interphalangeal joints (PIPJs) are important for normal hand function; both inflammatory and degenerative arthritis can affect the PIPJ leading to pain, stiffness, deformity and loss of function. The PIPJ is an important link of the kinetic chain of finger joint movement, providing approximately 40% of the total active range of movement in the finger (Herren and Simmen, 2004). It is functionally important for grasping smaller objects and handling irregularly shaped objects.

Burman (1940) first reported the use of a vitallium cap for PIPJ arthroplasty in 1940. In 1959, Brannon and Klein (1959) published the first series on prosthetic replacement for the PIPJ, reporting on a single stem, monoaxial hinged device that was originally designed for fracture dislocations of that joint. Flatt (1963) later published on a more rotationally stable device with two medullary prongs with indications for its use in degenerative arthritis of the PIPJ. The early experience of small joint arthroplasty was disappointing as it did not match the success of large joint replacements (Comtet, 1997) with unacceptable rates of implant failures and disappointing range of motion. Swanson (1969) developed a spacer for the resected arthritic PIPJ made from a durable, medical grade, heat vulcanized, silicone rubber that could withstand 50 million cycles before breakage. The silicone implant gained worldwide popularity and is currently regarded as being as successful as other non-linked implants with similar revision rates,

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outcomes and overall survival although fracture of the implant universally occurs (Daecke et al., 2012; Forster et al., 2018). Linscheid and Dobyns (1979) reported on a non-linked prosthesis made from cobalt chromium and ultra-high molecular weight polyethylene. The surgical technique was predicated on preservation of the collateral ligaments, which, in turn, was thought to unload the medullary stems of the prosthesis. Several other designs have been developed to reconstruct the PIPJ, but this remains a controversial area as some believe that silastic implants, first described by Swanson (1969), provide the best alternative for the arthritic PIPJ (Yamamoto et al., 2017).

The purpose of this review was to examine the current evidence-based indications for PIPJ arthroplasty and examine the reported, implant-specific outcomes of this procedure. Various techniques and rehabilitation strategies will also be outlined.

Indications

The historical indications for PIPJ arthroplasty were trauma and degenerative arthritis; however, with the improved control of rheumatoid arthritis (RA) after the introduction of biologic medication, the indications for surgery have evolved to include inflammatory cases. As with all arthroplasty, implant wear and loosening is more of a risk in younger more active patients but, in general, PIPJ arthroplasty is indicated in patients with moderate or severe degenerative changes and disabling pain that has failed to respond to non-operative treatment (Dickson et al., 2015; Herren and Simmen, 2000; Jennings and Livingstone, 2015; Marks et al., 2019; Murray et al., 2012; Reischenbock et al., 2021; Yamamoto et al., 2017). Recent studies have shown that outcomes of PIP arthroplasty in patients with inflammatory arthritis are not statistically different from patients with degenerative arthritis or post-traumatic arthritis (Murray et al., 2012). This is contrary to the traditional thought that PIPJ arthroplasty, particularly surface replacement designs, are contraindicated in inflammatory arthritis disease due to poor ligamentous integrity. This modification to include indication of PIP arthroplasty in the RA patient may be tied to the successes of both synthetic and biologic disease modifying antirheumatic drugs (DMARDs) now used routinely in inflammatory arthritis.

Before surgical intervention for PIPJ arthroplasty, non-operative treatment should be considered. This should include a trial of analgesics such as non-steroidal anti-inflammatory agents provided the patient can tolerate this medication, nighttime splinting of the affected PIPJs and activity facilitation/modification under the direction of a hand therapist. Although little literature exists to guide treatment, intra-articular or periarticular corticosteroid injections of the PIPJ may be helpful at least on a temporary basis (Habib et al., 2018; Spolidoro Paschoal Nde et al., 2015).

Severe bone loss with associated coronal plane deformity is a relative contraindication to PIPJ arthroplasty; however, recent studies have shown that experienced surgeons can reliably correct coronal deformities of 20°–25° (Meuser et al., 2024; Reischenbock et al., 2021). PIPJ arthroplasty is now indicated in all digits as some authors have reported that joint replacement in border digits (index and little) performs as well as the middle and ring fingers (Griffart et al., 2019; Murray et al., 2012). Specifically, joint replacement in the index finger avoids the risk of a mild quadriga effect that may result from an arthrodesis in an extended position (Schreuders, 2012).

If there is substantial bone loss, a traditional stemmed, non-linked or semi-constrained implant such as the DJO SRA (DJO, Dallas, TX, USA) (Murray et al., 2012) or Ascension pyrocarbon implant (Ascension Orthopedics Inc., Austin, TX, USA) may be indicated with impaction grafting (Oakes and Cabanela, 2006) as opposed to a true surface replacement implant such as the CapFlex (KLS Martin SE & Co. KG, Germany) (Meuser et al., 2024). Functioning flexor and extensor tendons and competent collateral ligaments are prerequisites for PIPJ implant arthroplasty, with sagittal plane deformity from boutonniere or swan neck formation being a contraindication to implant arthroplasty surgery.

The final cosmetic result is also important to patients (Chung et al., 2006), and a recent publication (Helder et al., 2021) showed a preference for correction of coronal plane deformity using a non-linked PIPJ replacement rather than a silicone spacer.

Technical considerations

Dorsal, palmar and lateral surgical approaches to the PIPJ for arthroplasty have all been used successfully (Fowler et al., 2021; Tranchida et al., 2021; Trumble and Heaton, 2017). The dorsal tendon-splitting approach, which involves detaching the central slip, is easier to perform and has been shown to have a low incidence of extension lag and fewer complications when compared to the Chamay tendon flap or the palmar approach (Afifi et al., 2010; Bodmer et al., 2020). The palmar approach has been shown in one study to have the best flexion range but the largest extension deficit (Bodmer et al., 2020).

Dorsal approach

The dorsal approach to the PIPJ affords wide exposure to the articular surface of the head of the proximal phalanx, the articular base of the middle phalanx, and the radial and ulnar collateral ligaments. A midline or curved incision is made over the PIPJ and the proximal phalanx with radial and ulnar full-thickness flaps raised. A dorsal tendon-splitting approach was originally described by Swanson (1969), which affords exposure to the PIPJ by incising the central slip, then elevating the central slip insertion off the middle phalanx in a subperiosteal plane distally enough until adequate exposure of the PIPJ is obtained. The dorsal osteophyte may need to be trimmed to allow access to the joint. A side-to-side suture of the extensor mechanism is recommended without reattachment of the central slip insertion to bone (Afifi et al., 2010).

A modification was described by Chamay (1988), in which a distally based isosceles trapezoid flap or triangular flap of the extensor mechanism is raised, protecting the insertion of the central slip on the middle phalanx. The dorsal capsule is incised but can be difficult to distinguish from the extensor mechanism in more advanced cases of degenerative PIP arthritis. After implant insertion, the tendon is sutured using braided non-absorbable interrupted 3-0 or 4-0 suture. The Chamay approach has a potential advantage of allowing 'rebalancing' of the extensor tendon, but is more demanding than a simple tendon-splitting approach as overtightening the repair risks a swan neck deformity and extensor scarring, which we have found to be less common with a simple tendon-splitting approach (Afifi et al., 2010).

Palmar approach

In the palmar approach, the PIPJ is approached through a Brunner incision centred over the PIPJ flexor crease. The radial and ulnar digital arteries and nerves are identified and protected. A window is made in the flexor tendon sheath including the C1, A3, and C2 pulleys. The flexor tendons are then retracted, and the palmar plate is released from its insertion on the base of the middle phalanx and its confluence with the radial and ulnar collateral ligaments. This then allows the PIPJ to be opened in a 'gunstock' fashion (if deemed appropriate) for preparation of the articular surfaces of the head of the proximal phalanx and the articular base of the middle phalanx. An alternative is to make the middle phalanx and the proximal phalangeal head cuts and simply translate the bones to prepare the canals (Herren and Simmen, 2000). The palmar approach also allows tightening of the palmar plate to correct a swan neck deformity; however, the instrumentation for many implants is designed for a dorsal approach.

Lateral approach

The theoretical advantage of the lateral approach to the PIPJ is that neither the extensor tendon apparatus nor the flexor tendon and flexor tendon sheath are disrupted. A mid-axial longitudinal incision is made over the ulnar side of the PIPJ and the full-thickness flaps elevated. The radial collateral ligament is preserved given its importance during pinch where upwards of 70 N of force can be created (Fowler et al., 2021). The distal insertion of the ulnar collateral ligament from the base of the middle phalanx is preferably detached, enabling the dislocation of the joint in the coronal plane. The proximal and middle phalanx cuts are made, and the canals are prepared based on the instrumentation used in the various PIPJ implant systems. Once the proper implants are chosen and inserted, the ulnar collateral ligament is repaired by to periosteum or to bone using a 3-0 or 4-0 braided non-absorbable suture. This can also be facilitated using a small suture anchor. This approach is technically difficult and limited access is available to osteophytes on the far side of the incision (Bain et al., 2015).

Bone preparation and instrumentation

Preparation of the bone ends once exposed is standard among all approaches. Using a microsagittal cutting saw, the head of the proximal phalanx is removed, depending on the implant used while sparing the collateral ligaments. There is a strong trend to release the origin of the collateral ligaments from the proximal phalanx much more liberally in an inside-out technique, creating a soft tissue sleeve that will fall back into position and heal accordingly, thus providing secondary joint stability. A thin portion of the base of the articular base of the middle phalanx is also removed with a saw or burr, depending on bone loss or subsidence on the middle phalanx and the thickness of the distal component of the prosthesis. The goal is to accurately restore the centre of rotation. Severe subsidence or protrusion of the head of the proximal phalanx into the base of the middle phalanx needs advanced planning of the resection line and may require correction using the PIPJ implants. Peripheral osteophytes are removed from about the proximal phalanx and the middle phalanx articular base. For a surface replacement, it is

particularly important to remove the palmar osteophytes from the head of the proximal phalanx.

If a stemmed implant is used, the middle phalanx and the proximal phalanx are prepared by broaching to the largest and best fit of the prosthetic trial implant while understanding that the stems may be too large to fit in the little finger.

The trial reduction should be checked for full passive range of motion without dorsal or palmar subluxation or dislocation. Accurate alignment and rotation of the implants are critical for stability and motion. However, in a study by Bodmer et al. (2023), there was no correlation between implant positioning and clinical results in a two-component implant, indicating that the importance of implant positioning remains a subject of further study.

Ultimately, there should be limited radial/ulnar rocking of the components with stressing of the joint; if the soft tissues are too tight there is a risk of flexion deformity and stiffness, while excessive laxity risks instability, including swan neck deformity. It is also worth noting that some modern implants, such as the CapFlex (KLS Martin SE & Co. KG, Germany) are designed for uncemented use; therefore, accurate positioning with good alignment and pressfit is critical.

Anaesthesia

Several anaesthetic techniques are available for implant arthroplasty of the PIPJ. General anaesthesia or a brachial plexus block are most commonly used but wide-awake local anaesthesia no tourniquet (WALANT), regional anaesthesia and digital block anaesthesia have all been reported with successful outcomes (Fowler et al., 2021; Sharma et al., 2023). WALANT and local anaesthesia have the advantage of permitting both active and passive motion of the PIPJ intraoperatively, which can also be demonstrated to the patient. This real-time visual cue can aid the patient in the rehabilitation process while enabling the surgeon to set realistic expectations for the patient, e.g. the range of motion that can be achieved. In a similar fashion but perhaps more challenging, individual digital block anaesthesia with either a finger tourniquet or a forearm tourniquet can also be used; however, the finger tourniquet can limit proximal exposure while a forearm tourniquet may be poorly tolerated after 30 minutes without some form of intravenous sedation.

Rehabilitation

Rehabilitation protocols are influenced by the surgical approach (Chamay, dorsal tendon splitting, palmar or lateral) and are patient specific. Irrespective of approach, immediately after surgery, the patient is splinted with the MCPJ in slight flexion and PIPJs just short of full extension. The dressings are removed at days 3–5 and a removeable resting orthosis is fabricated during the first postoperative week, again with the MCPJ in modest flexion and the PIPJs in extension. For the Chamay and dorsal tendon-splitting approaches, a regimen of gradual progressive short-arc active flexion with a flexion block is instituted over a 6-week period until unrestrictive motion is allowed. For the palmar and lateral approaches, early unrestricted active and passive range of motion is permitted after the initiation of rehabilitation under the supervision of a certified hand therapist. The digits are immobilized in the extension orthosis in between exercise sessions and at bedtime. All splints are typically discontinued by 6 weeks postoperatively.

Louvion et al. (2022) reviewed the postoperative management of 48 different PIPJ replacement series published after 2008, and they concluded that the precise recommendations for postoperative rehabilitation after PIPJ arthroplasty cannot be made based on the available evidence. The authors concluded that therapy protocols should be clarified through future clinical research. Different rehabilitation protocols for multiple finger PIP arthroplasty surgery are not needed, although rehabilitation after PIPJ arthroplasty of the little finger is more challenging. While prescriptive protocols are helpful, an individualized approach to rehabilitation may be necessary, with extension splinting for patients developing a flexion deformity and a dorsal block in slight PIP flexion if there is a risk of swan neck deformity.

Outcomes and complications

Over the last 80 years there have been many attempts at solving the challenge of PIPJ arthroplasty, with numerous implant designs to address loosening, implant survival and improved range of motion. Several, including the Moje ceramic implant (Moje Keramik-Implantate, Petersberg, Germany) (Wesemann et al., 2008) and LPM prosthesis (Van Straten Medical, De Meern, The Netherlands) (Field, 2008; Hobby et al., 2008), have had unacceptable failure rates, and many more have been withdrawn with no published long-term outcomes. In Europe, the Medical Devices Regulations now mandate collection and publication of outcome data for all implantable medical devices. Useful measures for data collection in PIPJ arthroplasty include the Patient-Acceptable Symptom State (PASS), which defines the highest level of symptom where the

patient sees themselves (Marks et al., 2019), as well as Minimal Important Change (MIC), which indicates the smallest change in a measure that the patient sees as relevant (Mokkink et al., 2010). It is our experience that patients' expectations and their engagement plays a large role in the overall outcome. Conditions such as anxiety, depression and post-traumatic stress disorders may also lead to poor outcomes, particularly if litigation is involved.

Pain relief

Almost all published series report useful pain relief with total joint replacement of the PIPJ, which is usually maintained at longer-term follow-up (Fowler et al., 2021; Lozano et al., 2022). Two recent studies have found that there is less benefit to surgery in those with little or no pain before surgery (Marks et al., 2024; Notermans et al., 2022) and approximately 50% of patients experience clinically relevant pain reduction (Notermans et al., 2022).

Range of motion

PIPJ arthroplasty maintains a functional range of motion with approximately 50° of flexion in most patients (Forster et al., 2018; Yamamoto et al., 2017). Postoperative mobility is predicted by the preoperative range of motion (Marks et al., 2024). It is unlikely that useful movement will be achieved if the finger is stiff before surgery (Dickson et al., 2015). Although there is a risk of a loss of range of motion if the patient has greater than 90° of flexion preoperatively, some recent publications have reported a modest improvement in range of motion after surgery (Fowler et al., 2021; Meuser et al., 2024; Reischenbock et al., 2021). Arthrodesis of a painful distal interphalangeal joint arthrodesis at the same time as PIP arthroplasty has been shown to improve PIPJ range of motion after arthroplasty (Hamano et al., 2021); however, care must be taken to avoid impingement if a cannulated screw is used with a stemmed PIPJ implant (Figures 1 and 2). Appropriate soft tissue balancing during surgery is critical to achieve optimal mobility. If the joint is 'over-stuffed', there is a risk of flexion deformity and stiffness. For some implants, the range of motion may deteriorate with longer-term follow-up (Shirakawa and Shirota, 2020; Sweets and Stern, 2010). Srnec et al. (2018) have shown that multiple digits can be treated during the same surgical sitting with pain improvement and range of motion similar to surgery performed on a single joint. The pain relief and improved motion when multiple joints are addressed can also facilitate rehabilitation.

Infection

Fortunately, infection is a rare complication in PIPJ replacement with rates of less than 1% in pooled data from over 1800 patients (Forster et al., 2018). Typical joint arthroplasty infection precautions are employed for all PIPJ arthroplasty procedures, including meticulous prepping and draping, proper sterilization of instruments, cautious handling of instruments and implants, through wound irrigation throughout the procedure, perioperative intravenous antibiotics (cephalosporin) administration, intraoperative patient temperature regulation to approximately 36°C, and preoperative assessment and optimization

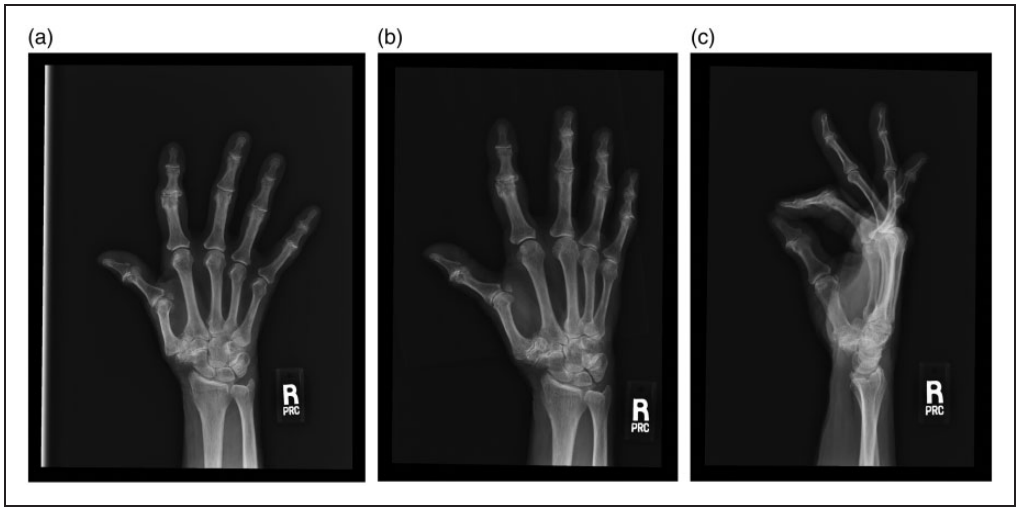

Figure 1. (a) Posteroanterior projection of a 76-year-old woman with a 5-year history of progressive right-hand pain and stiffness not responsive to splinting or oral non-steroidal anti-inflammatory medications. (b) Oblique projection of the right hand and (c) lateral projection of the right hand.

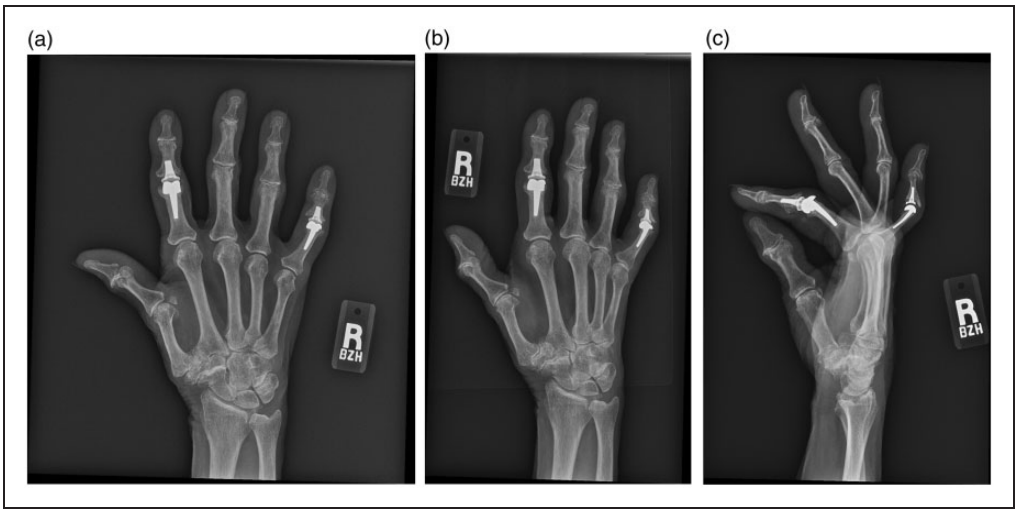

Figure 2. (a) Posteroanterior projection of the right hand 1 year after cementless surface replacement arthroplasty of the index and small finger proximal interphalangeal joints. One year after surgery, the active motion of the index finger was −20°/70° and small finger −30°/75°. The patient reported complete relief of hand pain. (b) Postoperative oblique projection and (c) postoperative lateral projection.

of medical comorbidities, such as diabetes mellitus, ensuring a Hb A1C of less than 8.0.

Instability and dislocation

Joint stability depends upon accurate insertion of an appropriately sized implant. Preservation of the collateral ligaments is important, and the risk of instability is greater if there is significant preoperative deformity, whether this is the result of soft tissue laxity or bone loss. Dislocation is infrequent in most reported series. If dislocation occurs, then closed reduction is usually possible; however, there remains a risk of recurrent instability, implant migration and stiffness. Hensler et al. (2020) found that PIP surface replacement arthroplasty achieves better anatomic stability when compared to silicone implant arthroplasty, while Helder et al. (2021) have shown that surface replacement is more reliable in correcting coronal plane deformities than silastic implants in a comparative series of 703 patients.

Implant migration and subsidence

All implants carry a risk of subsidence and migration, but this is most common with pyrocarbon implants (Forster et al., 2018; Yamamoto et al., 2017). In some cases, implants achieve secondary stability, but progressive migration with cortical perforation can occur. Implant migration can lead to late instability or stiffness. Achieving a good pressfit with an appropriately sized implant is important to minimize the risk of migration. Failure to achieve accurate alignment leads to eccentric forces across the joint and this increases

Figure 3. Posteroanterior and lateral projection of the right index finger of a 72-year-old woman with a painful proximal interphalangeal joint for several years.

the risk of implant migration, which has led some authors to advocate the use of cement to reduce the risk of implant migration (Jennings and Livingstone, 2015; Johnstone et al., 2008). Careful reaming with milled broaches under radiographic control allows an optimal pressfit and impaction bone graft can be used if required, particularly for revision surgery.

Sagittal plane deformities

Swan neck deformity and boutonniere can occur after surface replacement arthroplasty of the PIPJ due to

loss of palmar plate integrity after the palmar approach (swan neck development) or loss of extensor mechanism integrity after a dorsal approach (boutonniere deformity). When present preoperatively, swan neck deformity and boutonniere deformity are very difficult to correct when performing PIPJ implant arthroplasty.

Current evidence: what do we know?

Over the last 10 years, there has been an increase in studies reporting on outcomes after PIPJ constrained or semi-constrained arthroplasty for the finger, showing progressive overall improvements. Daecke et al. (2012) published a prospective randomized trial of 62 joints among three different devices with a mean follow-up of 35 months. The authors found all implants led to significant pain reduction irrespective of the device used and no significant differences were found with respect to range of motion. Satisfactory function and survival have been reported at the 5- to 10-year follow-up for stemmed metal on plastic implants, including the SRA (DJO Surgical, Dallas, TX, USA) (Murray et al., 2012) and the MatOrtho (MatOrtho Limited, Leatherhead, UK), which has a mobile bearing (Flannery et al., 2016; Fowler et al., 2021). Smaller series with shorter follow-ups have been reported for the Toccata implant (SEM, Créteil, France) (Kim et al., 2017), the TACTYS implant (DJO Surgical, Guildford, UK) (Lozano et al., 2022) and the self-locking finger joint (Teijin Nakashima Medical Co., Okayama, Japan) (Komatsu et al., 2018).

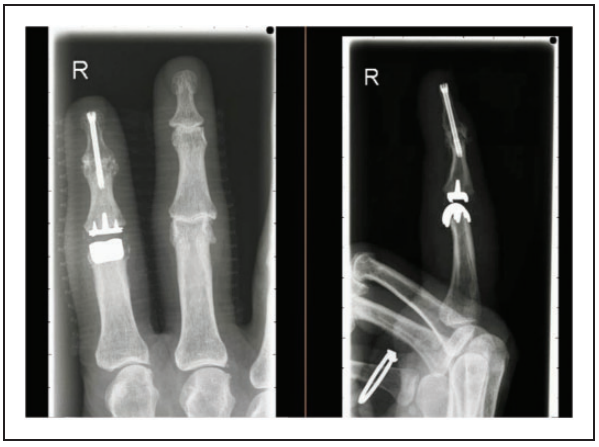

Figure 4. Four-year follow-up of the right index finger after cementless replacement arthroplasty using the CapFlex device.

The CapFlex (KLS Martin SE & Co. KG, Germany) is a novel stemless surface replacement (Figures 3 and 4) that has promising functional results and satisfactory implant survival at mid-term (3–5 years) follow-up (Meuser et al., 2024; Reischenbock et al., 2021).

The Pyrocarbon implant (Ascension Orthopedics Inc., Austin, TX, USA) has been one of the most widely used implants over the last 20 years, with acceptable mid-term clinical results; however, it is prone to migration radiographically with deterioration in function in the longer term (Dickson et al., 2015; Reischenbock et al., 2021; Reissner et al., 2014).

In patients with stiffness and limited motion after surgery, the first treatment is additional attempts at hand therapy focusing on passive stretches and

Table 1. Summary of recent follow-up studies for surface replacement implants.

Study	Joints	Implant	Follow-up (months)	Approach	Mean ROM (°)	Pain improved?	Implant survival
Fowler et al. (2021)	33	MatOrtho	34	L	57.9[a]	Yes	27/33
Lozano et al. (2022)	64	Tactys	37	D	46[b]	Yes	NA
Meuser et al. (2024)	67	CapFlex	35	D	70[b]	Yes	65/67
Reischenbock et al. (2021)	92	CapFlex	60	D/V	54[b]	Yes	88/92
Dickson et al. (2015)	51	Pyrocarbon	103	NA	54[b]	Yes	49/51
Jennings and Livingstone (2015)	39	SR PIP	111	D/V	56[b]	Yes	37/43
Johnstone et al. (2008)	43	SR PIP	60	D	52[b]	Yes	36/43
Murray et al. (2012)	67	SR PIP	106	D/V/L	40[b]	Yes	59/67
Flannery et al. (2016)	100	MatOrtho	47	D	34[a]	Yes	87/100
Kim et al. (2017)	32	Toccata	71	D	67[b]	Yes	30/32
Komatsu et al. (2018)	26	SLFJ	44	D/V	44[b]	Yes	25/26
Reissner et al. (2014)	17	Pyrocarbon	116	D/V	29[a]	Yes	16/17
Trumble and Heaton (2017)	21	SR PIP	34	V	87[b]	NA	21/21

[a]Mean ROM at follow-up represents a decrease from mean preoperative ROM.
[b]Mean ROM at follow-up represents an increase from mean preoperative ROM.
D: dorsal; L: lateral; NA: not available; ROM: range of motion; SLFJ: self-locking finger joint; SR PIP: Stryker surface replacement proximal interphalangeal arthroplasty; V: volar (palmar).

Table 2. Evidence-based pearls and pitfalls.

Pearls
Pain is reliably improved with PIPJ implant arthroplasty
Postoperative total active motion can be expected to be 50°
Best predictor of postoperative motion is preoperative motion
Dorsal approaches perform better overall than palmar approach
Infection is seldom seen in primary PIPJ arthroplasty
Preserve collateral ligament key for non-linked PIPJ arthroplasty
Good pressfit trialled to largest best fit implant is preferred, impact graft if necessary
Outcomes in inflammatory arthritis not significantly from degenerative
Outcomes of multiple PIPJ implants at same time similar to single-digit implant
Pitfalls
Difficult to maintain correction of sagittal plane deformity after PIPJ implant
Overstuffing implant risks flexion deformity
Loss of extensor tendon integrity may lead to boutonniere deformity
Loss of palmar plate integrity may lead to swan neck deformity
Postoperative instability greater in setting of notable preoperative coronal deformity
Consider conversion to more constrained silicone PIPJ after failed PIPJ non-linked implant
Conversion to PIPJ arthrodesis after failed PIPJ implant arthroplasty can be challenging

PIPJ, proximal interphalangeal joint.

static splinting for any extension lag. Our experience has been that there is a limited role for surgical soft tissue releases, but this is best done using the WALANT technique.

Radiolucent lines are seen in most series of PIP arthroplasty; however, in our experience, this does not necessarily portend implant failure or a poor result as the prosthesis may stabilize in a subsided position. Pyrocarbon implants do not osseointegrate and are usually easy to remove. The well-fixed surface replacement implant can be challenging to remove. Some implants come with extraction devices, but these may be of limited value, particularly if cement is present. In these settings, the use of small osteotomes and beaver blades are often necessary. Surface replacement designs, such as the Capflex, are easier to remove than a well-fixed stemmed implant. For the failed implant, conversion to a different implant, including the silicone-hinged implant, may be considered; however, changing to a more appropriately sized implant may be all that is needed. Conversion to a PIP arthrodesis may also be considered but is technically challenging due to bone loss and the resultant defect, a bone graft is often required Stabilization of the arthrodesis is best managed by a dorsal 2.0 mm plate. The authors of this study have limited experience with conversion of a PIP arthrodesis to a PIP arthroplasty and this surgery is not generally recommended.

Conclusion

PIPJ implant arthroplasty should be considered for symptomatic degenerative, post-traumatic or inflammatory PIP arthritis. There are multiple different options for PIPJ surface replacement arthroplasty and these can be implanted through a dorsal, palmar or lateral approach (Table 1). If current, design-specific surgical techniques for implantation and rehabilitation are followed, predictable pain relief with acceptable function and patient satisfaction can be anticipated. Unfortunately, complications include radiographic implant subsidence, implant loosening and sagittal plane deformities such as swan neck deformity and boutonniere deformity. In addition, stiffness and limited range of motion can be seen postoperatively but are generally tolerated when pain has been eliminated (Table 2). Silastic implants are easier to perform but tend to fail in higher demand, younger patients, with recurrent angular deformity in many patients. It is important to note that reviews of silicone implants are mainly for patients with RA while surface replacement studies deal with mixed indications with a larger percentage of patients with osteoarthritis. Total joint replacement is a demanding procedure, but it offers an alternative solution in well-motivated patients with good bone stock and little or no deformity. In patients with poor soft tissues, severe bone loss, severe deformity or stiffness, a silicone interposition arthroplasty or fusion may be preferable.

Declaration of conflicting interests The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: DH receives royalties from KLS Martin Tuttlingen Germany and KeriMedical Geneva Switzerland and has educational teaching contracts with both companies.

Funding The authors received no financial support for the research, authorship, and/or publication of this article.

References

Afifi AM, Richards A, Medoro A, Mercer D, Moneim M. The extensor tendon splitting approach to the proximal interphalangeal

joint: do we need to reinsert the central slip? J Hand Surg Eur. 2010, 35: 188–91.
Bain GI, McGuire DT, McGrath AM. A simplified lateral hinge approach to the proximal interphalangeal joint. Tech Hand Up Extrem Surg. 2015, 19: 129–32.
Bodmer E, Fiumedinisi F, Marks M, Neumeister S, Herren DB, Schindele S. Radiological positioning of a proximal interphalangeal joint resurfacing implant: reliability and functional outcomes correlation. Hand Surg Rehabil. 2023, 42: 115–20.
Bodmer E, Marks M, Hensler S, Schindele S, Herren DB. Comparison of outcomes of three surgical approaches for proximal interphalangeal joint arthroplasty using a surface-replacing implant. J Hand Surg Eur. 2020, 45: 608–14.
Brannon EW, Klein G. Experiences with a finger-joint prosthesis. J Bone Joint Surg Am. 1959, 41-A: 87–102.
Burman MS. Vitallium cup arthroplasty of metacarpophalangeal and interphalangeal joints of fingers. Bull Hosp Joint Dis. 1940, 1: 79–89.
Chamay A. A distally based dorsal and triangular tendinous flap for direct access to the proximal interphalangeal joint. Ann Chir Main. 1988, 7: 179–83.
Chung KC, Kotsis SV, Kim HM, Burke FD, Wilgis EF. Reasons why rheumatoid arthritis patients seek surgical treatment for hand deformities. J Hand Surg Am. 2006, 31: 289–94.
Comtet JJ. Table ronde sur les prostheses interphalangiennes proximales: conclusion. La Main. 1997, 2: 117.
Daecke W, Kaszap B, Martini AK, Hagena FW, Rieck B, Jung M. A prospective, randomized comparison of 3 types of proximal interphalangeal joint arthroplasty. J Hand Surg Am. 2012, 37: 1770–9.
Dickson DR, Nuttall D, Watts AC, Talwalkar SC, Hayton M, Trail IA. Pyrocarbon proximal interphalangeal joint arthroplasty: minimum five-year follow-up. J Hand Surg Am. 2015, 40: 2142–8.
Field J. Two to five year follow-up of the LPM ceramic coated proximal interphalangeal joint arthroplasty. J Hand Surg Eur. 2008, 33: 38–44.
Flannery O, Harley O, Badge R, Birch A, Nuttall D, Trail IA. MatOrtho proximal interphalangeal joint arthroplasty: minimum 2-year follow-up. J Hand Surg Eur. 2016, 41: 910–6.
Flatt AE. Restoration of Rheumatoid Finger-Joint Function. J Bone Joint Surg Am. 1963, 45: 1101–3.
Forster N, Schindele S, Audige L, Marks M. Complications, reoperations and revisions after proximal interphalangeal joint arthroplasty: a systematic review and meta-analysis. J Hand Surg Eur. 2018, 43: 1066–75.
Fowler A, Arshad MS, Talwalkar S, Trail I. MatOrtho proximal interphalangeal joint arthroplasty via lateral approach: minimum 2-year follow-up. J Hand Surg Asian Pac. 2021, 26: 339–44.
Griffart A, Agneray H, Loubersac T, Gaisne E, Bellemere P. Arthroplasty of the proximal interphalangeal joint with the Tactys([R]) modular prosthesis: results in case of index finger and clinodactyly. Hand Surg Rehabil. 2019, 38: 179–85.
Habib G, Sakas F, Artul S, Khazin F. The effect of periarticular injection of methylprednisolone acetate in patients with primary osteoarthritis of the proximal interphalangeal joints: a case controlled study. Pain Res Treat. 2018, 2018: 7561209.
Hamano H, Kawamura D, Iwasaki N. Concomitant arthrodesis of the distal interphalangeal joint with surface replacement arthroplasty of the proximal interphalangeal joint: a comparative study in 11 patients. J Hand Surg Eur Vol. 2021, 46: 416–7.
Helder O, Marks M, Schweizer A, Herren DB, Schindele S. Complications after surface replacing and silicone PIP arthroplasty: an analysis of 703 implants. Arch Orthop Trauma Surg. 2021, 141: 173–81.
Hensler S, Behm P, Wehrli M et al. Lateral stability in healthy proximal interphalangeal joints versus surface replacement and silicone arthroplasty: results of a three-dimensional motion analysis study. Hand Surg Rehabil. 2020, 39: 296–301.
Herren DB, Simmen BR. Palmar approach in flexible implant arthroplasty of the proximal interphalangeal joint. Clin Orthop Relat Res. 2000: 131–5.
Herren DB, Simmen BR. Proximal interphalangeal arthroplasty with special reference to Swanson silastic implants. In: Simmen BR, Allieu Y, Lluch A, Stanley J (Eds.) Hand Arthroplasties, London, Martin Dunitz, 2004: 331–7.
Hobby JL, Edwards S, Field J, Giddins G, Research, Audit Committee of the BSSH. A report on the early failure of the LPM proximal interphalangeal joint replacement. J Hand Surg Eur Vol. 2008, 33: 526–7.
Jennings CD, Livingstone DP. Surface replacement arthroplasty of the proximal interphalangeal joint using the SR PIP implant: long-term results. J Hand Surg Am. 2015, 40: 469–73.
Johnstone BR, Fitzgerald M, Smith KR, Currie LJ. Cemented versus uncemented surface replacement arthroplasty of the proximal interphalangeal joint with a mean 5-year follow-up. J Hand Surg Am. 2008, 33: 726–32.
Kim W, Renaud B, Dumontier P, Condamine JL. Results of Toccata ([R]) resurfacing PIP joint arthroplasty. A series of 32 cases at a mean follow-up of 5.9 years. Hand Surg Rehabil. 2017, 36: 405–9.
Komatsu I, Arishima Y, Shibahashi H, Yamaguchi T, Minamikawa Y. Outcomes of surface replacement proximal interphalangeal joint arthroplasty using the self locking finger joint implant: minimum two years follow-up. Hand (N Y). 2018, 13: 637–45.
Linscheid RL, Dobyns JH. Total joint arthroplasty. The hand. Mayo Clin Proc. 1979, 54: 516–26.
Louvion E, Santos C, Samuel D. Rehabilitation after proximal interphalangeal joint replacement: a structured review of the literature. Hand Surg Rehabil. 2022, 41: 14–21.
Lozano A, Cholley-Roulleau M, Degeorge B, Dautel G. Proximal interphalangeal joint arthroplasty with the Tactys(R) prosthesis: clinical and radiological outcomes at a mean 3.1 years' follow-up. Hand Surg Rehabil. 2022, 41: 226–33.
Marks M, Hensler S, Wehrli M, Schindele S, Herren DB. Minimal important change and patient acceptable symptom state for patients after proximal interphalangeal joint arthroplasty. J Hand Surg Eur Vol. 2019, 44: 175–80.
Marks M, Oyewale M, Neumeister S, Schindele S, Herren DB. Preoperative thresholds of pain and function to achieve a minimal important change and patient acceptable symptom state after proximal interphalangeal joint arthroplasty. J Hand Surg Am. 2024, 49: 382.e1–.e7.
Meuser S, Richter M, Kernich N. Prosthetic arthroplasty of the proximal interphalangeal joint using a surface replacing implant (CapFlex-PIP): 3-year outcomes. J Hand Surg Eur Vol. 2024, 49: 477–82.
Mokkink LB, Terwee CB, Knol DL et al. The COSMIN checklist for evaluating the methodological quality of studies on measurement properties: a clarification of its content. BMC Med Res Methodol. 2010, 10: 22.
Murray PM, Linscheid RL, Cooney WP 3rd, Baker V, Heckman MG. Long-term outcomes of proximal interphalangeal joint surface replacement arthroplasty. J Bone Joint Surg Am. 2012, 94: 1120–8.
Notermans BJW, van der Oest MJW, Selles RW, de Boer LHL, Hand-Wrist Study Group, van der Heijden B. Patient-reported outcomes 1 year after proximal interphalangeal joint arthroplasty for osteoarthritis. J Hand Surg Am. 2022, 47: 603–10.

Oakes DA, Cabanela ME. Impaction bone grafting for revision hip arthroplasty: biology and clinical applications. J Am Acad Orthop Surg. 2006, 14: 620–8.

Reischenbock V, Marks M, Herren DB, Schindele S. Surface replacing arthroplasty of the proximal interphalangeal joint using the CapFlex-PIP implant: a prospective study with 5-year outcomes. J Hand Surg Eur Vol. 2021, 46: 496–503.

Reissner L, Schindele S, Hensler S, Marks M, Herren DB. Ten year follow-up of pyrocarbon implants for proximal interphalangeal joint replacement. J Hand Surg Eur Vol. 2014, 39: 582–6.

Schreuders TAR. The quadriga phenomenon: a review and clinical relevance. J Hand Surg Eur Vol. 2012, 37: 513–22.

Sharma S, Ong J, Putti A. Proximal interphalangeal joint arthroplasty using the wide-awake local anesthesia no tourniquet technique. Hand (N Y). 2023, 18: 612–5.

Shirakawa K, Shirota M. Surface replacement arthroplasty using a palmar approach for osteoarthritis of proximal interphalangeal joint: results after a minimum 5-year follow-up. Hand (N Y). 2020, 15: 81–6.

Spolidoro Paschoal Nde O, Natour J, Machado FS, de Oliveira HA, Furtado RN. Effectiveness of triamcinolone hexacetonide intraarticular injection in interphalangeal joints: a 12-week randomized controlled trial in patients with hand osteoarthritis. J Rheumatol. 2015, 42: 1869–77.

Srnec JJ, Wagner ER, Rizzo M. Impact of multi- versus single finger proximal interphalangeal joint arthroplasty: analysis of 249 fingers treated in 15 years. J Hand Surg Eur Vol. 2018, 43: 524–9.

Swanson AB. Finger joint replacement by silicone rubber implants and the concept of implant fixation by encapsulation. Ann Rheum Dis. 1969, 28 Suppl: 47–55.

Sweets TM, Stern PJ. Proximal interphalangeal joint prosthetic arthroplasty. J Hand Surg Am. 2010, 35: 1190–3.

Tranchida GV, Allen ST, Moen SM, Erickson LO, Ward CM. Comparison of palmar and dorsal approach for PIP arthroplasty. Hand (N Y). 2021, 16: 348–53.

Trumble TE, Heaton DJ. Outcomes of surface replacement proximal interphalangeal joint arthroplasty through a palmar approach: a prospective study. Hand (N Y). 2017, 12: 290–6.

Wesemann A, Flugel M, Mamarvar M. [Moje prosthesis for the proximal interphalangeal joint]. Handchir Mikrochir Plast Chir. 2008, 40: 189–96.

Yamamoto M, Malay S, Fujihara Y, Zhong L, Chung KC. A Systematic review of different implants and approaches for proximal interphalangeal joint arthroplasty. Plast Reconstr Surg. 2017, 139: 1139e–51e.