Arthritis of the Thumb Interphalangeal and Finger Distal Interphalangeal Joint

John C. Wu, MD*, James H. Calandruccio, MD, William Jacob Weller, MD, Peter R. Henning, MD, Colin W. Swigler, MD

KEYWORDS

• Distal interphalangeal joint • Arthritis • Arthrodesis • Arthroplasty • Mucous cyst

KEY POINTS

- The interphalangeal joints are subjected to the highest joint forces in the hand.
- At least 60% of individuals older than age 60 years have distal interphalangeal (DIP) joint arthritis, but not all experience symptoms.
- Physiologically younger and healthier patients put higher loads on the joint for a longer time than do older, less healthy patients. These increased loads increase the risk of implant failure, making arthrodesis an attractive option, especially in young, active patients.
- Interphalangeal arthrodesis has high fusion rates, with few complications, regardless of the method of fixation.

Osteoarthritis (OA) commonly affects the finger distal interphalangeal (DIP) or the thumb interphalangeal (IP) joints, which are subjected to high joint reactive forces and undergo more wear and tear than other joints in the hand. It is estimated that at least 60% of individuals older than age 60 years have DIP joint arthritis, but not all experience symptoms.[1–3] In the early stages, the joints may be painful and swollen despite normal radiographs. As the arthritis progresses, osteophytes and mucous cysts may develop; bony prominences (Heberden nodes) and angular deformities in both the coronal and sagittal planes may also develop. In the final stages, DIP joint motion may be severely restricted, making common household tasks such as opening containers, writing, and manipulating small objects, difficult or impossible. Physical examination should include the appearance of joints and overlying skin, active and passive range of motion of the affected joints, stability, grip and pinch strength, and sensibility. Adjacent joints also should be examined because chronic DIP OA resulting in a flexion deformity can cause a secondary hyperextension deformity of the proximal interphalangeal (PIP) joint that may be more disabling than the DIP deformity. The thumb IP joint degeneration similarly may manifest early with pain and mucous cysts and later with angular and rotary defects. Radiographs typically show joint space narrowing, osteophytes, bone cysts, and sclerosis of the subchondral bone.

MUCOUS CYSTS

Mucous cysts are ganglion cysts that arise from an osteoarthritic DIP joint. They typically are painless and often present on one side of the extensor tendon, between the extensor tendon and the adjacent collateral ligament. Occasionally, the mucous cyst can compress the nail's

Disclosure Statement: The authors have nothing to disclose.
Department of Orthopaedic Surgery and Biomedical Engineering, University of Tennessee-Campbell Clinic, 1211 Union Avenue, Suite 510, Memphis, TN 38104, USA
* Corresponding author.
E-mail address: john.cheeon.wu@gmail.com

Orthop Clin N Am 50 (2019) 489–496
https://doi.org/10.1016/j.ocl.2019.05.004
0030-5898/19/

germinal matrix, causing ridging, a longitudinal groove in the nail (Fig. 1). If the cyst continues to enlarge, more severe nail deformities can occur with further compression.[4] Concave nail plate deformities secondary to ganglion (mucous) cyst compression of the germinal matrix are frequent. Given the subcutaneous location of the cyst, the overlying skin can become attenuated and the cyst can spontaneously drain. There is a possibility that a mucous cyst can result in a draining sinus, and infection of the finger can present in varying degrees of severity:cellulitis, soft-tissue abscess, or a septic DIP joint.[5] Patients should be counseled to avoid the temptation to puncture the cyst using nonsterile and/or ablation or cautery techniques because they usually are ineffective and increase the risk of infection.

Treatment of Mucous Cysts

In general, mucous cysts may not require treatment if there is no significant pain or signs of infection. Some cysts spontaneously resolve and others may be associated with well-tolerated nailplate deformities. Aspiration followed by steroid injection and compression wrap is a reasonable treatment option for cysts that fail to spontaneously resolve, and this can be done in the office setting.[6,7] Multiple passes are made through the cyst to facilitate decompression, and some advocate passing the needle through the joint capsule in an attempt to disrupt the source.[8] Open surgical treatment is indicated for most cysts, especially those that recur after aspiration and injection or in the presence of suspected infection. Some patients may opt to forego aspiration and injection given the higher possibility of recurrence compared with surgical excision.[8]

Surgical Considerations

The surgical approach is similar to that used for IP or DIP fusion (Fig. 2), with the exception that the extensor tendon should be left intact and protected throughout the procedure. The overlying skin can be excised through an elliptical incision or carefully elevated off the cyst (Fig. 3). The cyst is excised, along with a small portion of the joint capsule and any soft tissue between the extensor tendon and the adjacent collateral ligament. The other side of the extensor tendon can be exposed in a similar manner to expose the entire DIP joint to ensure adequate osteophyte excision, because a cyst emerging from one side of a digit may be from a lesion on the opposite side. Care should be taken not to disrupt the germinal matrix to avoid iatrogenic postoperative nail deformities.

With the DIP joint held in hyperextension, the terminal extensor tendon is carefully elevated off the phalanx proximally for protection, while preserving its distal insertion (Fig. 4). Removal of all surrounding osteophytes is imperative to minimize recurrence; however, excision of the cyst sac itself may not be necessary, especially if it risks violation of the germinal matrix.[9,10] Some osteophytes may have a higher chondral composition and are not always appreciated on plain

Fig. 1. Mucous cyst in finger of patient with osteoarthritis.

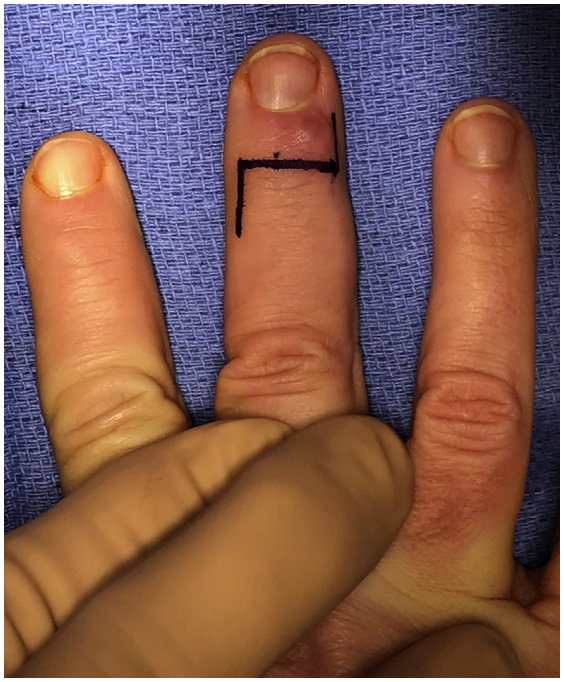

Fig. 2. Surgical approach for cyst excision.

Fig. 3. Overlying skin elevated off the cyst.

Fig. 4. Excision of cyst.

radiographs, but are easily seen during surgery. A rotation flap or skin graft can be used if the wound cannot be primarily closed, although this is rarely required.[8]

Outcomes and Complications

Recurrence rates have been reported to range from 50% to 100% after aspiration and injection.[6–8] Surgical procedures that include cyst removal, partial capsulectomy, and osteophyte excision are highly successful and have much lower recurrence rates. Eaton and colleagues[9] reported 1 recurrence in a series of 44 digits, Kleinert and colleagues[11] had no recurrences in 36 cases, Fritz and colleagues[12] reported a 3% recurrence rate (JHS 1997;22B), and Rizzo and Beckenbaugh[8] reported no recurrences in 83 digits (including 29 cysts that failed to respond to aspiration and injection) with a minimum follow-up of 2 years.

Nail ridging usually resolves after joint debridement and cyst decompression. Fritz and colleagues[12] reported a 60% resolution rate of nail ridging, Kasdan and colleagues[13] had a 90% resolution, and Rizzo and Beckenbaugh[8] reported an 80% resolution rate after surgical removal. None of these studies identified factors that could increase the likelihood of persistent deformity.

Complications such as stiffness of the DIP joint, infection, persistent nail deformity, swelling, and pain appear to occur at equal rates, regardless of whether surgery or aspiration and injection is performed.[8,12] Infection rates generally are low and infection usually are superficial, such that they can be treated with oral antibiotics.[8] Infection rates are reported to be as low as 2% with needle procedures,[6,8] and between 2% and 3% for surgical

procedures.[12,13] Stiffness, pain, and swelling rates ranged from 9% to 14%.[8,12,13] With the exception of infection, these complications appear to be relatively well tolerated and do not compromise clinical results.[8] Iatrogenic nail deformity is a complication that is more commonly associated with surgery and has been reported as a 7% risk in 1 study[12] and 0% in another.[8]

DISTAL INTERPHALANGEAL JOINT ARTHRODESIS

Although the appearance of the hand may be a primary patient concern, operative treatment generally should not be undertaken for strictly cosmetic reasons, but for DIP and IP deformities that interfere with hand function or severely limit motion. The functional impact of the terminal joint arthritis should be clearly defined, because sometimes quite marked visual deformities and underlying radiographic changes are associated with little functional impairment. In addition to risks and benefits of the procedure, patient expectations, handedness, occupation, and avocational activities should be discussed before surgery. Physiologically younger and healthier patients put higher loads on the joint for a longer time than do older, less healthy patients. These increased loads increase the risk of implant failure, making joint debridements and arthrodeses attractive options, especially in young, active patients. Preoperative splinting in the desired fusion position can confirm the patient's satisfaction with the position before the procedure is performed. DIP and IP joint arthroplasties are associated with substantially higher failure rates than is fusion because of the small bone dimensions and high forces across the joint; it rarely is performed. Terminal joint fusions are well tolerated and are extremely durable.

Surgical Considerations

Exposure

Surgical approaches to the DIP and IP joints include a curved dorsal incision in line with the skin creases, a dorsal H-type incision with the transverse portion parallel to the skin crease, and a transverse skin incision centered over the terminal joint with contralateral proximal and distal longitudinal extensions. When fusions are to be done, the terminal slip of the extensor tendon is transected just proximal to the joint, and the distally based terminal slip is left attached to the dorsal lip of the distal phalanx. The terminal slip is dissected sharply over the distal phalanx dorsal rim; this exposes an often elongated rim for resection and also protects the germinal matrix. The collateral ligaments are released from the neck of the middle phalanx of the fingers or the thumb proximal phalanx, allowing the joint to hyperflex to expose the entire mating surfaces of the degenerative joint.

Bone preparation

Articular cartilage and subchondral bone are removed until healthy cancellous bone is exposed. A prominent and elongated dorsal articular rim, as well as any protruding osteophytes (especially on the finger middle phalanx or thumb proximal phalanx dorsal head), should be removed. A small rongeur is ideal for this purpose. Exposure of cancellous bone is required on the mating surfaces to be fused, and sometimes the wear pattern on significantly angled DIP joints requires contouring to angles other than 90° for maximal cancellous contact with collinear middle-distal phalanx alignment. A cup-and-cone configuration is the most commonly used, although some surgeons use flat, angled surface cuts at the fusion site. Regardless of the method chosen for fusion, it is imperative to resect any soft tissue that may be interposed in the fusion site. Thus, redundant capsular tissue and collateral ligaments often are excised for both exposure and bone apposition.

Renfree[14] compared the results of percutaneous in situ arthrodesis with open arthrodesis of the DIP joint, and found that solid fusion occurred in 10 of 17 with percutaneous in situ arthrodesis compared with 11 of 12 with open arthrodesis. He concluded that open arthrodesis is better because it allows osteophyte removal and better correction of angular deformity in the coronal plane.

Method of fixation

DIP joint fusion rates are high with most fixation devices (Table 1). The technically simplest fixation is achieved with crossed Kirschner wires, which are left in to maintain the desired angular and rotational position until fusion is achieved. The wires usually are left buried, although a percutaneous method can be used. Headless screws are a popular fixation method and are associated with high fusion rates and less frequent device irritation (Fig. 5). Dickson and colleagues[15] compared Kirschner wires, cerclage wires, and headless screws and found no difference in infection rates, but higher fusion rates with headless screws. More recently, shape-memory (nitinol) staples have been reported to

Table 1
Advantages and disadvantages of fixation methods for DIP arthrodesis

Fixation Method	Advantages	Disadvantages
Kirschner wires	High fusion rate (92%–100%)	Risk of pin track infection
Interosseous wires	High fusion rate (88%–100%)	Implant prominence, may require second procedure for removal
Headless compression screws	High fusion rate (85%–100%) Stability across fusion site, no implant prominence	Difficulty in obtaining fusion in flexion, size mismatch between bone and screw, increased cost, possible nail deformity, screw cutout, screw breakage, retained implant
Headed screws	High fusion rate (95%–100%)	Prominent screw heads
Nitinol implant (X-fuse)	High fusion rate (89%–95%), allow 35° of flexion	Cost

obtain high fusion rates with few complications, with an advantage over screws of allowing 35° of flexion when desired; these devices, however, are more expensive than other fixation methods and are not intramedullary and risk causing nail matrix damage. Auzias and colleagues[16] described the use of a titanium intramedullary implant (Lync, Novastep) that is, available in straight or bent configurations, does not require removal, and can be inserted without fingertip incisions. Twenty (91%) of 22 joints were fused at latest follow-up (15 months), 18 (82%) within 3 months, and pain and function were improved. The authors cited less bulk and no need for removal as advantages of this device.

Position of fusion

Ideally, the natural cascade of the hand should be preserved to present the most aesthetically pleasing outcome. The natural cascade can be calculated on the basis of the position of the resting index finger. The index MP joint is generally positioned in 25° of flexion, and the index PIP joint is generally positioned in 40° of flexion. Flexion of the MP and PIP joints progresses in a radial-to-ulnar direction by approximately 5° per digit. Flexion of the DIP joints remains relatively constant at approximately 5°. Comparing the flexion of the joints with that of the opposite hand or with the ipsilateral hand (if the other joints are well preserved) can help guide the fusion position. Although appearance is

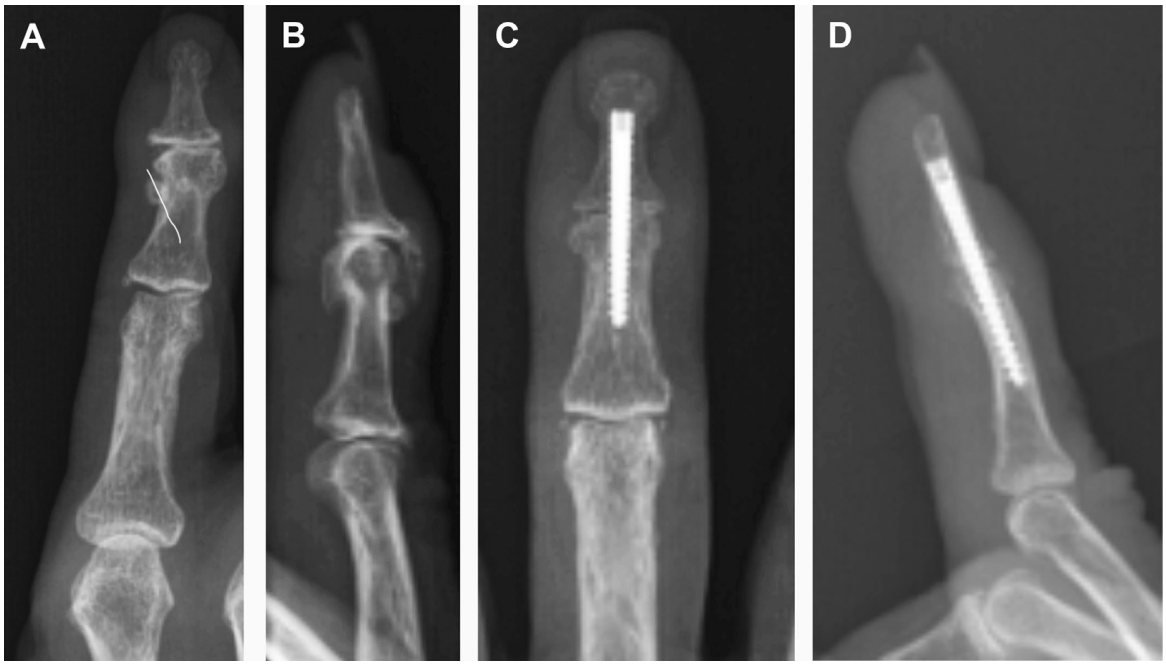

Fig. 5. (*A*, *B*) Osteoarthritis of the distal interphalangeal joint. (*C*, *D*) After fusion with a headless screw.

important, the primary concern should be function. Patients who desire a higher degree of dexterity, such as musicians, some athletes, and workers with various tools, may prefer a slightly more flexed position. The increasing use of digital devices has added another layer to the controversy over fusion position. Melamed and colleagues[17] evaluated dexterity and grip strength in 46 subjects after simulated DIP joint fusion. Index finger dexterity scores were improved when the DIP joint was splinted in 20° compared with full extension. Positioning the middle finger DIP joint in either extension or 20° of flexion did not significantly affect grip strength and dexterity; however, positioning the DIP joint in 20° of flexion may improve grip strength and dexterity over positioning it in neutral.

Outcomes and complications

Regardless of the fixation method used, fusion rates ranging from 85% to 100% have been reported with DIP arthrodesis (see Table 1). In their systematic review, Dickson and colleagues[15] reported a 96% fusion rate in 492 arthrodeses with screw fixation and a 92% fusion rate in 389 arthrodeses with K-wire fixation. Complications are infrequent (approximately 2% in most studies) and include primarily infection, skin necrosis, and implant problems (prominent screw, screw cutout, broken screw).

IMPLANT ARTHROPLASTY

DIP joint implant arthroplasty is less commonly used to treat painful DIP joint arthritis, but is a viable option when maintaining motion is desired, such as in musicians.[18] The technique uses small silicone implants that can be implanted into any digit, but it is important to protect the collateral ligaments when the procedure is done on the index digit to avoid postoperative instability from the large ulnar deviating forces from the thumb during pinch.[19]

Technique: Implant Arthroplasty

A variety of dorsal incisions can be used to expose the DIP joint. Variations in technique include preserving or dividing the extensor tendon just proximal to the DIP joint to allow extended exposure. Hyperflexion of the distal phalanx also can aid in visualization when the extensor tendon is divided. Extensor tendon preservation requires elevation of the collateral ligaments from the distal phalanx and removal of all soft tissue lateral to the extensor tendon. The DIP joint can then be accessed through these lateral windows with lateral flexion of the distal phalanx.[19] Careful manipulation and traction should be performed to avoid intraoperative extensor tendon rupture. The middle and distal phalanx bony surfaces are prepared using an oscillating saw or rongeur. The intramedullary canal can be prepared with a small power burr or hand-held reamers. Trial implants are used to determine the appropriate size required to optimize motion and stability. After the definitive prosthesis is implanted, the extensor tendon is repaired using nonabsorbable suture if divided during exposure. Kirschner wire fixation has been described to stabilize the DIP joint in extension at the conclusion of the procedure. The technique, as described in multiple articles, requires a Kirschner wire to be inserted in a retrograde fashion through the distal phalanx into the volar portion of the flexor tendon sheath, just proximal to the DIP joint, while avoiding the implant.[20–22] Understandably, this technique is not always adopted, and extension postoperative splinting can also be done.[19,23]

Outcomes of Implant Arthroplasty

Snow and colleagues[24] reported good results with pain relief and maintenance of 40° to 45° of active motion in 7 digits. Brown[23] reported high patient satisfaction, with all 21 patients reporting complete pain relief at an average follow-up of 26 months. There was an average active range of motion of 30°, which was 9° less than preoperative values. Extensor lag was not considered a complication in this series and the average postoperative extensor lag was 12°. In this study, the extensor tendon was divided and postoperative splinting without K-wire fixation was used.

Zimmerman and colleagues[21] reported 38 digits with an average follow-up of 6 years. All patients reported decreased pain and the average active postoperative range of motion was 33° with an average extension lag of 13°. This series also divided the extensor tendon but also used postoperative K-wire fixation.[20–22]

The most recent review reported 131 replacements in 85 patients with an average follow-up of 3 years.[19] This study had 2 groups representing the different approaches, extensor tendon division and preservation, and found no statistical difference between groups regarding extensor lag, range of motion, or improvement of pain. Their other results also supported previous literature regarding reliable improvement in pain and maintaining active range of motion (mean of 39°). The mean postoperative extensor lag was 11°. Interestingly, postoperative extensor lag was observed in most digits,

regardless of preservation or division of the extensor tendon. This could be due to the chronic attenuation of the terminal tendon secondary to dorsal osteophytes, with their removal causing postoperative laxity and extensor lag, or from shortening of the distal digit where the length of bone resected is more than the length provided by the implant.

Complications of Silicone Implant Arthroplasty

Brown and colleagues[23] reported 1 (5%) complication in 21 digits, a perforation of the implant through the dorsal cortex of the distal phalanx, leading to infection. Zimmerman and colleagues[21] reported 3 (10%) complications in 31 digits that required implant removal; 1 patient had an implant that eroded through the skin, another had a presumed infection, and one had persistent joint instability that eventually resulted in a phalangeal fracture. Sierakowski and colleagues[19] reported a 5% complication rate in 131 digits, with complications including superficial infection, osteomyelitis, persistent mallet deformity, lateral instability, and inadequate osteophyte resection. Fusion was the most common treatment of a failed DIP joint implant arthroplasty in all of these studies.

OTHER ARTHROPLASTY OPTIONS

When treating a painful mobile arthritic DIP joint, alternative techniques can provide pain relief while preserving range of motion and avoiding potential complications associated with implant arthroplasty. Volar plate advancement arthroplasty along with K-wire fixation can be an effective surgical treatment of posttraumatic DIP joint arthritis.[25] This technique is more commonly described for posttraumatic arthritic changes after chronic dorsal fracture-dislocation injuries of the PIP joint, but good results were reported in a series of 10 digits, with minimal to no pain and preserved average active range of motion of 42°.[25] Interpositional arthroplasty, using a free extensor retinaculum or palmaris longus tendon graft, also has been described for symptomatic arthritic DIP joint with good results in a small series of 5 digits.[26] Another surgical option with reported successful results is open cheilectomy and debridement.[27]

SUMMARY

The IP and DIP joints are subjected to the highest joint forces in the hand, and at least 60% of individuals older than age 60 years have DIP joint arthritis. Regardless of the fixation method, DIP fusion has high success rates, is well tolerated, and is extremely durable, making it an attractive option for younger, active patients. Less active and older patients are also well served by DIP fusion, which yields stability and increases strength required for normal daily living activities.

REFERENCES

1. Dahaghin S, Bierma-Zeinstra SM, Ginai AZ, et al. Prevalence and pattern of radiographic hand osteoarthritis and association with pain and disability (the Rotterdam study). Ann Rheum Dis 2005;64:682–7.
2. Kalichman L, Cohen Z, Kobyliansky E, et al. Patterns of joint distribution in hand osteoarthritis: contribution of age, sex, and handedness. Am J Hum Biol 2004;16:125–34.
3. Wilder FV, Barrett JP, Farina EJ. Joint-specific prevalence of osteoarthritis of the hand. Osteoarthritis Cartilage 2006;14:953–7.
4. Brown RE, Zook EG, Russell RC, et al. Fingernail deformities secondary to ganglions of the distal interphalangeal joint (mucous cysts). Plast Reconstr Surg 1991;87:718–25.
5. Rangarathnam CS, Linscheid RL. Infected muous cyst of the finger. J Hand Surg Am 1984;9:245–7.
6. Epstein E. A simple technique for managing digital mucous cysts. Arch Dermatol 1979;115:1315–6.
7. Goldman JA, Goldman L, Jaffe MS, et al. Digital mucinous pseudocysts. Arthritis Rheum 1977;20:997–1002.
8. Rizzo M, Beckenbaugh RD. Treatment of mucous cysts of the fingers: review of 134 cases with minimum 2-year follow-up evaluation. J Hand Surg Am 2003;28:519–24.
9. Eaton RG, Dobranski AI, Littler JW. Marginal osteophyte excision in treatment of mucous cysts. J Bone Joint Surg Am 1973;55:570–4.
10. Lee HJ, Kim PT, Jeon IH, et al. Osteophyte excision without cyst excision for a mucous cyst of the finger. J Hand Surg Eur Vol 2014;39(3):258–61.
11. Kleinert HE, Kutz JE, Fishman JH, et al. Etiology and treatment of the so-called mucous cyst of the finger. J Bone Joint Surg Am 1972;54:1455–8.
12. Fritz GR, Stern PJ, Dickey M. Complications following mucous cyst excision. J Hand Surg Br 1977;22:222–5.
13. Kasdan ML, Stallings SP, Leis VM, et al. Outcome of surgical treated mucous cysts of the hand. J Hand Surg Am 1994;19:504–7.
14. Renfree KJ. Percutaneous in situ versus open arthrodesis of the distal interphalangeal joint. J Hand Surg Eur Vol 2015;40:379–83.
15. Dickson DR, Mehta SS, Nuttall D, et al. A systematic review of distal interphalangeal joint arthrodesis. J Hand Microsurg 2014;6:74–84.

16. Auzias P, Delarue R, Strouk G, et al. Distal interphalangeal joint arthrodesis with the intramedullary Lync® implant: prospective study of 22 cases. Hand Surg Rehabil 2019;38:114–20.
17. Melamed E, Polatsch DB, Beldner S, et al. Simulated distal interphalangeal joint fusion of the index and middle fingers in 0° and 20° of flexion: a comparison of grip strength and dexterity. J Hand Surg Am 2014;39:1986–91.
18. Schwartz DA, Peimer CA. Distal interphalangeal joint implant arthroplasty in a musician. J Hand Ther 1998;11:49–52.
19. Sierakowski A, Zweifel C, Sirotakova M, et al. Joint replacement in 131 painful osteoarthritis and posttraumatic distal interphalangeal joints. J Hand Surg Eur Vol 2012;37:304–9.
20. Wilgis EFS. Distal interphalangeal joint silicone interpositional arthroplasy of the hand. Clin Orthop Relat Res 1997;342:38–41.
21. Zimmerman NB, Suhey PV, Clark GL, et al. Silicone interpositional arthroplasty of the distal interphalangeal joint. J Hand Surg Am 1989;14:882–7.
22. Zimmerman NB, Zimmerman SI, Wilgis EF. Distal interphalangeal joint silicone interpositional arthroplasy: surgical technique and functional outcome. Semin Arthroplasty 1991;2:153–7.
23. Brown LG. Distal interphalangeal joint flexible implant arthroplasty. J Hand Surg Am 1989;14:653–6.
24. Snow JW, Boyes JG, Greider JL. Implant arthroplasty of the distal interphalangeal joint of the finger for osteoarthritis. Plast Reconstr Surg 1977;60:558–60.
25. Rettig ME, Dassa G, Raskin KB. Volar plate arthroplasty of the distal interphalangeal joint. J Hand Surg Am 2001;26:940–4.
26. Aslam MZ, Ahmed SK, Fung B. New technique: tendon interposition arthroplasty in distal interphalangeal joint arthritis in Chinese population – new horizon for treatment. J Pak Med Assoc 2015;65(11 Suppl 3):S8–11.
27. Lin EA, Papatheodorou LK, Sotereanos DG. Cheilectomy for treatment of symptomatic distal interphalangeal joint osteoarthritis: a review of 78 patients. J Hand Surg Am 2017;42(11):889–93.