

Proximal Interphalangeal Finger Arthroplasty with Double Osteochondral Rib Graft. Case Report and Description of the Surgical Technique

Ricardo M. Gardenal, Renzo A. Carcuro, Jorge A. Bichara, Matías S. Seri, Sebastián J. Faccendini, Iván Camizasca, Eddy Massolas, Nicolás Scaiano, Martín E. Romaldini, Juan Ignacio Godoy

Sanatorio Plaza, Rosario, Argentina

ABSTRACT

We present the case of a 27-year-old male patient with a gunshot wound and severe proximal interphalangeal joint injury in the ring finger of the right hand, treated with a double osteochondral rib graft. He had an exposed fracture and a lack of bone and cartilage stock in both the first and second phalanx. After the initial toilette, at 3 weeks, a proximal interphalangeal arthroplasty was performed with a double osteochondral rib graft protected by a Suzuki external distractor. The surgical technique is described in detail. At 10 weeks after surgery, an active interphalangeal joint flexion of 75° and active extension of -15° were verified, without articular instability. The patient returned to work at 3 months after surgery, with no residual pain (0 VAS score) and a DASH score of 14.2. Radiographs showed incorporated grafts without resorption and a congruent joint. This technique is valued for its low morbidity on the donor site and versatility for joint defect reconstructions. The limitations of our study are mentioned. The clinical case presented obtained a satisfactory subjective and objective early functional outcome. Further complications cannot be ruled out.

Keywords: Proximal interphalangeal arthroplasty; osteochondral rib graft.

Level of Evidence: IV


Artroplastia interfalángica proximal de dedo de la mano con doble injerto osteocondral de costilla. Reporte de un caso y descripción de la técnica quirúrgica

RESUMEN

Se presenta el caso de un hombre de 27 años con una lesión grave articular interfalángica proximal en el dedo anular de la mano derecha, provocada por un proyectil de arma de fuego, que fue tratada con doble injerto osteocondral de costilla. Tenía una fractura expuesta y déficit de stock óseo y cartilaginoso tanto en la primera como en la segunda falange. Luego de la limpieza inicial, a las 3 semanas, se realizó una artroplastia interfalángica proximal con doble injerto osteocondral de costilla y fijador externo distractor de Suzuki. Se describe con detalle la técnica quirúrgica. A las 10 semanas posoperatorias, la flexión activa interfalángica era de 75° y la extensión activa, de -15°, con articulación estable. Alta laboral a los 3 meses de la cirugía, sin dolor y un puntaje DASH de 14,2. Las radiografías mostraron la incorporación de los injertos, sin reabsorción y con una articulación congruente. Se valora la ventaja de esta técnica en cuanto a la escasa morbilidad para la zona dadora y la versatilidad para las reconstrucciones con defectos articulares. El resultado funcional temprano subjetivo y objetivo fue satisfactorio. No se pueden descartar complicaciones futuras.

Palabras clave: Artroplastia interfalángica proximal; injerto osteocondral; costilla.

Nivel de Evidencia: IV

Received on October 27th, 2020. Accepted after evaluation on March 25th, 2021 • Dr. RICARDO M. GARDENAL • drmartingardenal@gmail.com  <https://orcid.org/0000-0003-0013-9275>

How to cite this article: Gardenal RM, Carcuro RA, Bichara JA, Seri MS, Faccendini SJ, Camizasca I, et al. Proximal Interphalangeal Finger Arthroplasty with Double Osteochondral Rib Graft. Case Report and Description of the Surgical Technique. *Rev Asoc Argent Ortop Traumatol* 2021;86(5):651-658. <https://doi.org/10.15417/issn.1852-7434.2021.86.5.1279>

INTRODUCTION

Traumatic injuries involving the proximal interphalangeal joint cartilage cause severe limitations in range of motion and finger dexterity, impairing global hand function.¹

The objective of this article is to present the case of a young adult patient with a proximal interphalangeal joint injury of the ring finger of the right hand, caused by a firearm projectile that caused a loss of bone stock and joint cartilage in the distal region of the first phalanx and proximal region of the second phalanx. After the initial debridement, in a second surgical stage, arthroplasty was performed using a double osteochondral rib graft.

CLINICAL CASE

A 27-year-old man suffered an exposed fracture in the proximal interphalangeal joint of the ring finger of the right hand caused by a firearm projectile with an entry and exit hole. On radiographs, 40% of the joint surface was compromised in its ulnar sector (with a defect in the distal region of the first phalanx and proximal region of the second phalanx); furthermore, the fracture extended to the diaphysis of the second phalanx (Figure 1).



Figure 1. Anteroposterior and lateral radiographs of the ring finger upon admission.

Upon the patient's admission, a mechanical-surgical debridement was performed, an ulnar gutter splint was placed and he received antibiotic prophylaxis with cephalexin.

In a second stage, three weeks after the initial injury, he underwent a proximal interphalangeal arthroplasty with a double osteochondral rib graft for the proximal and middle phalanges, protected with a Suzuki distraction external fixator.

Surgical technique

Preparation

Before anesthesia, it is useful to mark the osteochondral junction of the eighth rib ipsilateral to the affected limb on the skin. This junction is located horizontally at the level of the spinous process of the twelfth thoracic vertebra, two thirds from the circumference of the hemithorax, as described by Lepage et al. (Figure 2).²



Figure 2. Preoperative marking of the osteochondral donor site.

Injury exploration

The proximal interphalangeal joint of the ring finger is exposed through a dorsal-ulnar incision with an ulnar-based V flap. The damaged cartilage is resected along with the subchondral and metaphyseal bone, and the defect is prepared to receive the graft, both in the distal region of the proximal phalanx and at the base of the middle phalanx. As the bone portion of the graft must be large enough to allow good fixation, the graft bed is enlarged as needed, as recommended by Sato et al. (Figure 3).³

Rib graft

According to the technique proposed by Loisel et al.,⁴ a 4-cm thoracic incision is performed along the anterior aspect of the eighth rib, slightly directed inwards and downwards. The periosteum and perichondrium of the rib are sectioned and curetted, separating them from the bone and cartilage, respectively. The graft is lifted; the osseous part with an oscillating saw and the cartilaginous part is cut with a scalpel. In our case, a tricortical graft was taken, leaving the deep posterior bone aspect of the rib and its cartilage intact at the donor site (Figure 4).



Figure 3. Proximal interphalangeal approach and exposure.

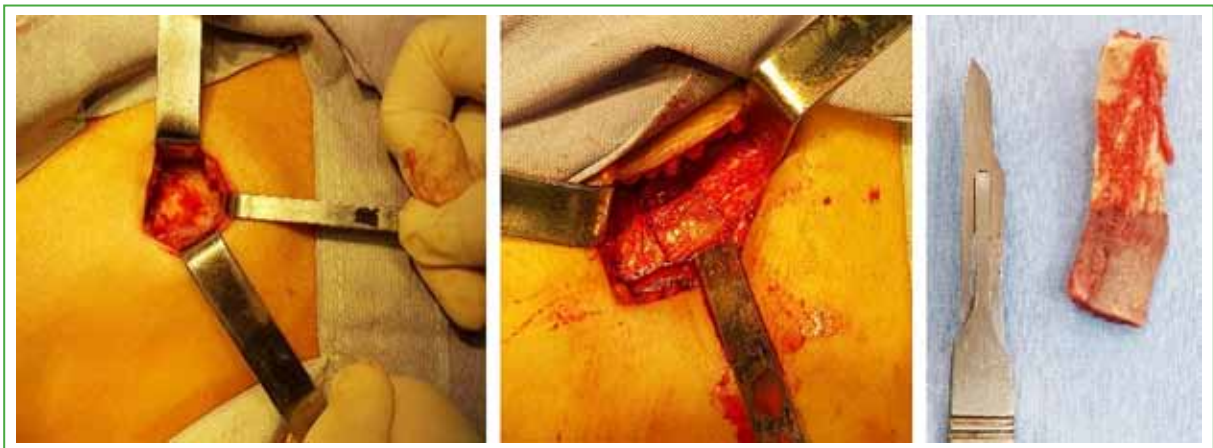


Figure 4. Taking an osteochondral graft.

Osteosynthesis of the graft and assembly of the Suzuki tutor

The graft was divided in two, longitudinally, to reconstruct the middle and proximal phalanx, both with their osteochondral junction. Both grafts were fixated in their osseous portion with two 1.3 mm screws (Profyle Hand, Stryker®, Mahwah, NJ, USA) and then a distraction tutor was mounted with the Suzuki technique,⁵ under image intensifier control. The wounds were closed by planes in the ring finger and the thorax, without the need for drainage, and an ulnar gutter slab was placed (Figures 5 and 6).

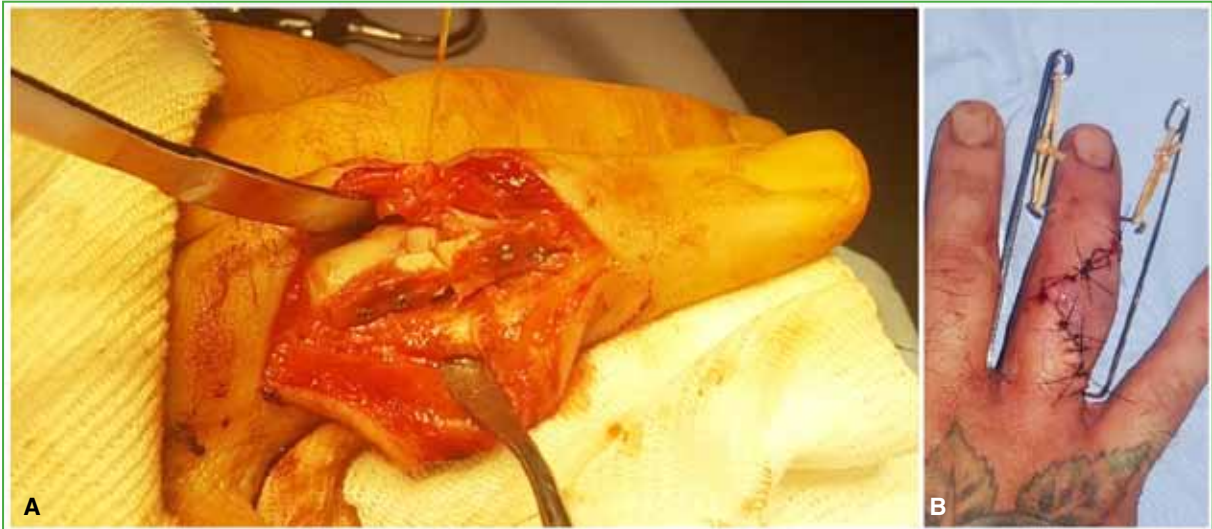


Figure 5. Intraoperative images. **A.** Screw osteosynthesis. **B.** Placed distractor.

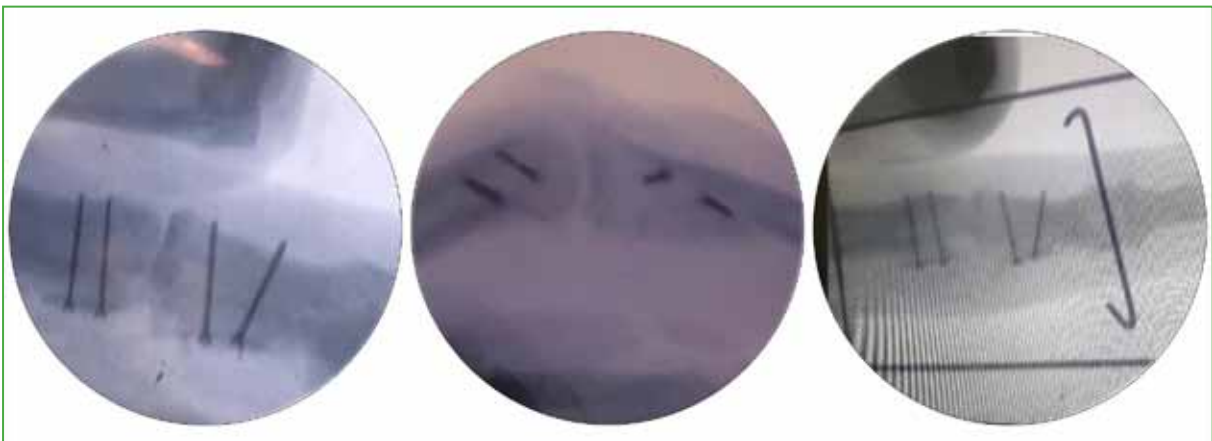


Figure 6. Intraoperative fluoroscopic images.

Postoperative rehabilitation

Mobilization of the proximal interphalangeal joint of the ring finger began on the sixth postoperative day. At that time, the use of the rest splint was discontinued and the patient began physiotherapy sessions. The distraction device was removed one month after surgery.

The patient was evaluated with serial radiographic controls and finger goniometry in the consultations and at the final discharge; the pain was assessed with the visual analog scale and the DASH questionnaire.⁶

One month after surgery, the radiographs revealed clear signs of bone consolidation of the two grafts, with joint congruence both before removing the distraction external tutor and after doing so (Figure 7).

10 weeks after the operation, an active proximal interphalangeal flexion of 75° and an active extension of -15° with stable articulation were verified using goniometry.

The patient returned to work activities three months after surgery, without pain (visual analog scale 0) and a DASH⁶ score of 14.2. In the radiographs, the incorporation of the grafts was observed, without resorption and with joint congruence (Figure 8).

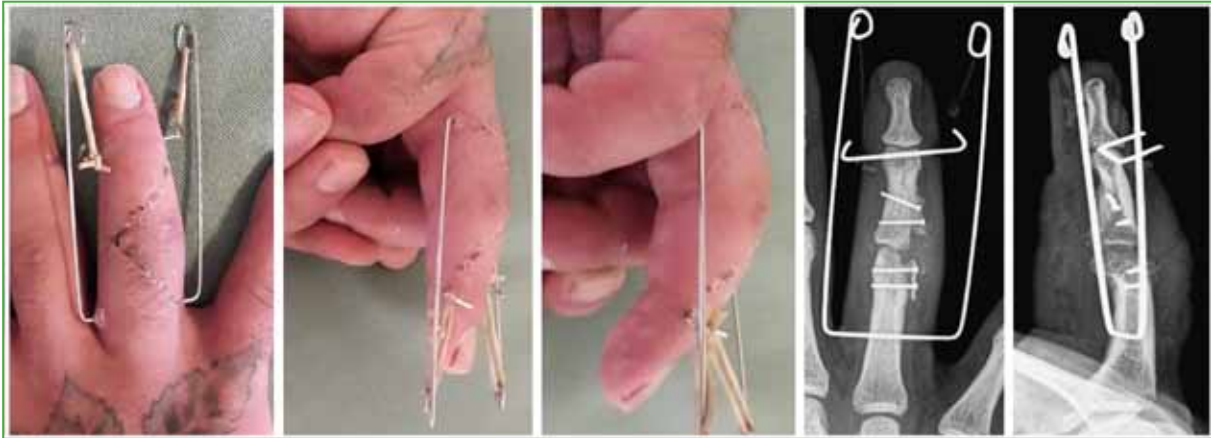


Figure 7. Clinical and radiographic images one month after surgery.

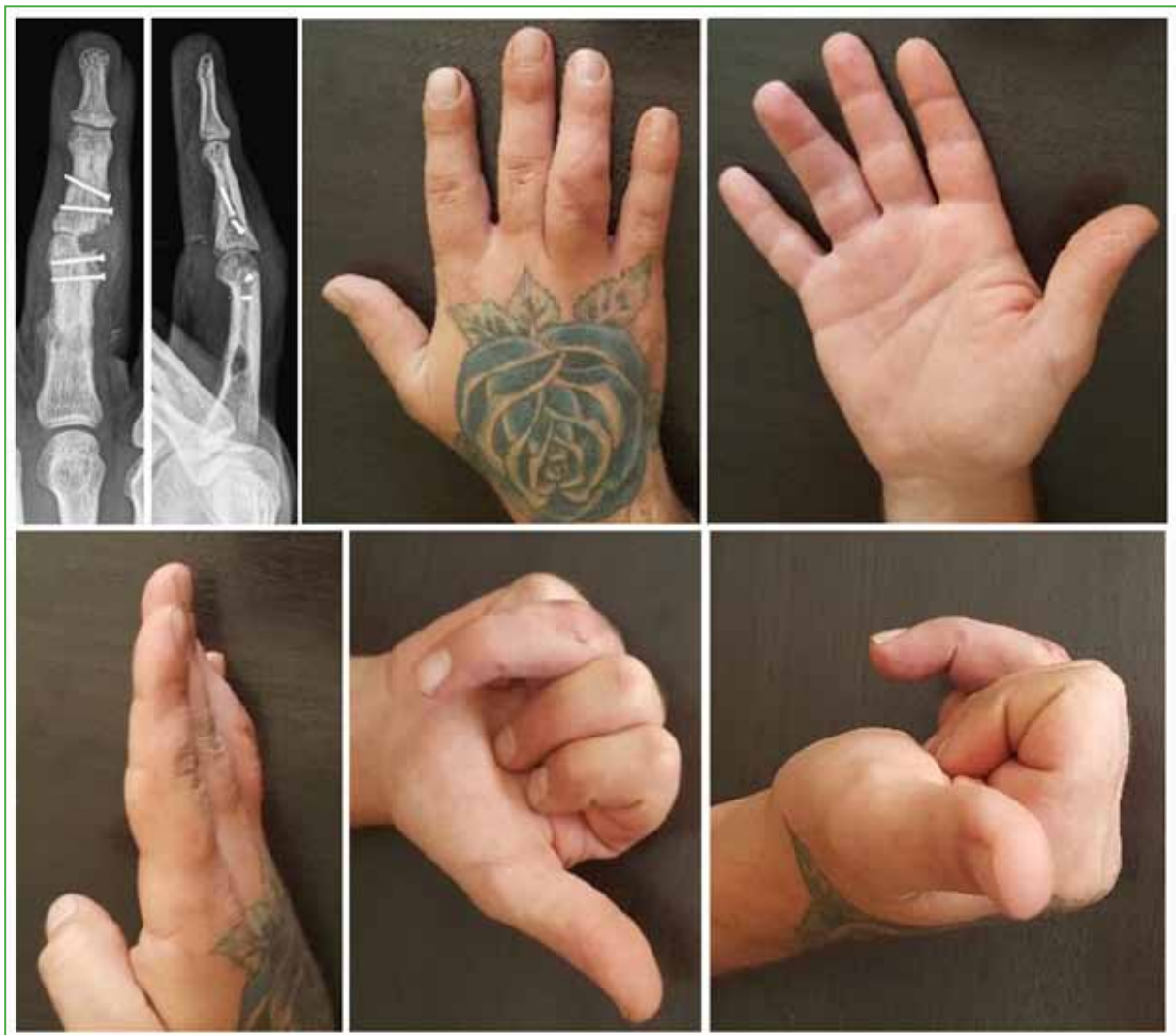


Figure 8. Radiographs and clinical evolution at the time of discharge.

DISCUSSION

The treatment of intra-articular fractures of the fingers is usually very complex, especially in those cases that present with great comminution, lack of bone stock, and articular cartilage defect.¹

Many procedures attempting to restore the anatomy and functionality of the proximal interphalangeal joint have been published, such as Eaton's interposition arthroplasty,⁷ joint denervation,⁸ artificial joint replacement,^{9,10} non-vascularized partial joint transplantation of the foot¹¹ or the hand (hamate bone, for example)¹² or free vascularized transplantation of a toe joint for the hand.^{13,14} In cases of sequelae, a proximal interphalangeal arthrodesis can also be performed to improve the function of the affected finger, despite blocking the mobility of the joint in question.¹⁵

An alternative to these therapies is the osteochondral rib graft that was initially described by Gilles¹⁶ in 1920, using it to reconstruct the temporomandibular joint. In 1992, Hasegawa et al. used these grafts in the proximal interphalangeal joint.¹⁷

The rate of complications at the donor site is low and allows reconstruction of the defect, without damaging other joints. Even large joint defects or the entire proximal interphalangeal joint can be replaced, since it is possible to obtain a considerable amount of material, without functional consequences at the donor site. Our patient had no acute or subacute intraoperative or postoperative complications.

We recognize some clear limitations in this work. This is a case report, without a control group to compare outcomes. In addition, the short postoperative follow-up does not allow us to rule out medium and long-term complications, such as cartilage necrosis, graft reabsorption or degenerative joint changes.

CONCLUSION

In the clinical case presented, the subjective and objective functional outcome was satisfactory at the time of final discharge. Difficulties or complications in the future cannot be ruled out.

Conflict of interest: The authors declare they do not have any conflict of interests.

R. A. Carcuro ORCID ID: <https://orcid.org/0000-0002-2292-6774>
 J. A. Bichara ORCID ID: <https://orcid.org/0000-0002-3624-2488>
 M. S. Seri ORCID ID: <https://orcid.org/0000-0001-7219-712X>
 S. J. Faccendini ORCID ID: <https://orcid.org/0000-0001-8035-6055>
 I. Camizasca ORCID ID: <https://orcid.org/0000-0002-8715-8569>

E. Massolas ORCID ID: <https://orcid.org/0000-0002-6473-667X>
 N. Scaiano ORCID ID: <https://orcid.org/0000-0002-8869-3504>
 M. E. Romaldini ORCID ID: <https://orcid.org/0000-0003-4702-052X>
 J. I. Godoy ORCID ID: <https://orcid.org/0000-0002-9628-3740>

REFERENCES

1. Satake Y, Nanno M, Kodera N, Takai S. Use of a costal osteochondral graft for reconstruction of a proximal phalanx head with a comminuted fracture of the proximal interphalangeal joint. *J Nippon Med Sch* 2020;87:37-42. https://doi.org/10.1272/jnms.JNMS.2020_87-107
2. Lepage D, Tatu L, Loisel F, Rey PB, Obert L, Parratte B. Anatomical and computed tomography study of the eighth costochondral junction: topography for costochondral graft harvesting. *Surg Radiol Anat* 2016;38(7):809-15. <https://doi.org/10.1007/s00276-016-1635-8>
3. Sato K, Nakamura T, Nakamichi N, Okuyama N, Yoshiaki TY, Ikegami H. Finger joint reconstruction with costal osteochondral graft. *Tech Hand Up Extrem Surg* 2008; 12(3):150-5. <https://doi.org/10.1097/BTH.0b013e31816d92ad>
4. Loisel F, Pluvy I, Kielwasser H, Panouilleres M, Obert L, Lepage D. Technical note on the harvesting of rib osteochondral autografts for upper limb bone and joint repair surgery. *Hand Surg Rehabil* 2018;37(6):337-41. <https://doi.org/10.1016/j.hansur.2018.07.005>
5. Suzuki Y, Matsunaga T, Sato S, Yokoi T. The pins and rubbers traction system for treatment of comminuted intraarticular fractures and fracture-dislocations in the hand. *J Hand Surg Br* 1994;19(1):98-107. [https://doi.org/10.1016/0266-7681\(94\)90059-0](https://doi.org/10.1016/0266-7681(94)90059-0)

6. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) [corrected]. The Upper Extremity Collaborative Group (UECG). *Am J Ind Med* 1996; 29(6):602-8. [https://doi.org/10.1002/\(SICI\)1097-0274\(199606\)29:6<602::AID-AJIM4>3.0.CO;2-L](https://doi.org/10.1002/(SICI)1097-0274(199606)29:6<602::AID-AJIM4>3.0.CO;2-L)
7. Malerich MM, Eaton RG. The volar plate reconstruction for fracture-dislocation of the proximal interphalangeal joint. *Hand Clin* 1994;10(2):251-60. PMID: 8040203
8. Jiménez I, Marcos-García A, Muratore G, Caballero-Martel J, Medina J. Denervation for proximal interphalangeal joint osteoarthritis. *J Hand Surg Am* 2020;45(4):358.e1-358.e5. <https://doi.org/10.1016/j.jhsa.2019.07.012>
9. Wagner ER, Luo TD, Houdek MT, Kor DJ, Moran SL, Rizzo M. Revision proximal interphalangeal arthroplasty: an outcome analysis of 75 consecutive cases. *J Hand Surg Am* 2015;40:1949-55. <https://doi.org/10.1016/j.jhsa.2015.05.015>
10. Wagner ER, Weston JT, Houdek MT, Luo TD, Moran SL, Rizzo M. Medium-term outcomes with pyrocarbon proximal interphalangeal arthroplasty: a study of 170 consecutive arthroplasties. *J Hand Surg Am* 2018;43(9):797-805. <https://doi.org/10.1016/j.jhsa.2018.06.020>
11. Podolsky D, Mainprize J, McMillan C, Binhammer P. Comparison of third toe joint cartilage thickness to that of the finger proximal interphalangeal (PIP) joint to determine suitability for transplantation in PIP joint reconstruction. *J Hand Surg Am* 2011;36(12):1950-8. <https://doi.org/10.1016/j.jhsa.2011.09.013>
12. Leclère FM, Haug L, Meier R, Surke C, Unglaub F, Vögelin E. Non-vascularized partial joint transfer for finger proximal interphalangeal joint reconstruction: a series of 9 patients. *Arch Orthop Trauma Surg* 2020;140(1):139-44. <https://doi.org/10.1007/s00402-019-03301-9>
13. Foucher G, Merle M, Maneaud M, Michon J. Microsurgical free partial toe transfer in hand reconstruction: a report of 12 cases. *Plast Reconstr Surg* 1980;5:616-27. <https://doi.org/10.1097/00006534-198005000-00013>
14. Dautel G. Vascularized toe joint transfers to the hand for PIP or MCP reconstruction. *Hand Surg Rehabil* 2018;37(6):329-36. <https://doi.org/10.1016/j.hansur.2018.03.008>
15. Millrose M, Zach A, Kim S, Güthoff C, Eisenschenk A, Vonderlind HC. Biomechanical comparison of the proximal interphalangeal joint arthrodesis using a compression wire. *Arch Orthop Trauma Surg* 2019;139(4):577-81. <https://doi.org/10.1007/s00402-019-03119-5>
16. Gillies HD. *Plastic surgery of the face*. London: Oxford University Press; 1920:13-15, 177-182.
17. Hasegawa T, Yamano Y. Arthroplasty of the proximal interphalangeal joint using cartilage grafts. *J Hand Surg Br* 1992;17:583-5. [https://doi.org/10.1016/s0266-7681\(05\)80248-7](https://doi.org/10.1016/s0266-7681(05)80248-7)