



Case Report

Complex open elbow fracture Gustilo–Anderson type IIIB treated with the primary elbow arthroplasty: A case report

Zoltan Cibula ^{a, b}, Maros Hrubina ^{a, b, *}, Jenó Kiss ^c, Marian Melisik ^{a, b}, Libor Necas ^{a, b}^a Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Kollarova 2, Martin, 03659, Slovak Republic^b University Department of Orthopaedic Surgery, University Hospital Martin, Kollarova 2, Martin, 03659, Slovak Republic^c Department of Orthopaedic and Traumatologic Surgery, Szent Janos Hospital Budapest, Dios Arok 1-3, Budapest, 1125, Hungary

ARTICLE INFO

Article history:

Received 29 February 2020

Received in revised form

7 November 2020

Accepted 17 November 2020

Available online 9 December 2020

Keywords:

Elbow arthroplasty

Complications

Complex open elbow fracture

ABSTRACT

Total elbow arthroplasty as a treatment option for open elbow fracture is relatively rare described. We reported a 39 years old polytrauma patient with complex open elbow fracture (Gustilo–Anderson type IIIB). The patient presented with large soft tissues defect on dorsal part of the left elbow, ulnar palsy due to the irreparable loss of the ulnar nerve, distal triceps loss due to the complete loss of the olecranon, loss of both humeral condyles with collateral ligaments and complex elbow instability. Only few similar cases have been published. Reconstructive surgery included repetitive radical debridement, irrigation, vacuum assisted closure system therapy, external fixation, coverage of the soft tissue defect with fascia–cutaneous flap from the forearm. Four months after the injury, total elbow arthroplasty with autologous bone graft (from the proximal radius) inserted in the ulnar component, was performed. At 3 years postoperatively, the patient is able to perform an active flexion from 0° to 110° with full pronosupination. Only passive extension is allowed. The ulnar neuropathy is persistent. Patient has no signs of infection or loosening of the prosthesis.

© 2020 Chinese Medical Association. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Complex Gustilo–Anderson type IIIB open elbow fracture are rare injuries resulting from high-energy trauma.^{1,2} Large soft tissues damages with comminuted fractures in the elbow are frequently combined with neuro-circulatory lesions. The soft tissues injury located at the dorsal part of the elbow is commonly associated with ulnar nerve damage. These injuries may lead to a severe limitation of motion or to a complete function loss of the upper extremity. Recommended treatment has not been defined clearly yet. Despite the fact of comminution and the defects of the articular and metaphyseal parts of the bones, there is a minimal chance to achieve mobile and stable elbow with the use of osteosynthesis in these patients.³ Such injuries require individual planning, repetitive debridement, temporarily external fixation, and defect closure with application of the vacuum assisted closure (VAC) system.⁴ Timing and decision about final treatment,

individual orthoses, arthrodesis or total elbow arthroplasty (TEA) are crucial.^{5–7} Our case represented final treatment of this severe injury with TEA.

Case report

Case history

The patient is a 39-year-old right-handed male. The patient suffered cervical column fracture, rib fractures, lung contusion, spleen contusion, duplex fracture of the left femur, scapula fracture and complex open fracture of the left elbow Gustilo–Anderson type IIIB (Fig. 1A and B).¹ The latter fracture was classified according to AO/OTA as follows distal humerus fracture 13-C3, proximal forearm fracture 21-B1.

In the first hospital, the intramedullary osteosynthesis of the femoral fracture was performed. Wound revision, irrigation and large debridement of the elbow fracture was performed with removal of bone fragments of 7 cm size from both humeral condyles and proximal ulnar metaphysis. The irreparable loss of ulnar nerve and the loss of distal triceps with insertion was diagnosed. The bridging external fixator (Synthes GmbH, Oberdorf,

* Corresponding author. Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Kollarova 2, Martin, 03659, Slovak Republic.

E-mail address: mhrubina@gmail.com (M. Hrubina).

Peer review under responsibility of Chinese Medical Association.



Fig. 1. The initial X-rays of the affected left elbow of the 39 years old patient. (A) Picture after the injury with the large comminution of the proximal ulna and distal humerus. Small foreign parts (sand and metal parts) are visible. (B) Picture of the complex elbow fracture before first debridement.

Switzerland) on the left elbow with the VAC system (VivanoTec, Hartmann, Heidenheim, Germany) on the soft tissues defect was used.

Two weeks after injury, the patient was transported to the workplace of the authors. We decided treatment strategy for the left elbow (Fig. 2). Patient received intravenous (IV) Ampicillin 2 g every 6 h for 3 weeks and IV Voriconazol 300 mg every 12 h for 10 days. Debridement, irrigation and VAC system exchange was performed 3 times after each 5–6 days. The microbiological finding from the defect was positive – presence of *Staphylococcus haemolyticus* was observed. So, IV Vancomycin 1 g every 12 h for 10 days was added. Five weeks after the injury, when the overall wound state was satisfactory and the repetitive microbiological findings was negative, the soft tissue defect was covered with fascia – cutaneous flap from the forearm (Fig. 3). IV Cefuroxime 1.5 g every 12 h for 7 days was administered and then 500 mg every 12 h per orally was used for next 3 weeks in total.

After the surgery, the external fixator was removed and the left upper extremity was immobilized with the cast for 2 weeks. The wounds healed primary (per primam intentionem) without any sign of infection. The patient was able to walk with one crutch and was discharged for ambulatory treatment with left elbow in individual orthosis 2 months after injury. The left elbow was

completely unstable with atrophic muscles. Therefore, TEA was indicated, which was implanted 4 months after injury, when C-reactive protein (CRP), erythrocyte sedimentation ratio (ESR) and white blood cells (WBC) count were normal (CRP 4 mg/L, ESR 8/16 mm/h, WBC $6.0 \times 10^9/L$).

Surgery

Surgery was performed in general anaesthesia with tourniquet. Vancomycin IV 1 g every 12 h was administered for 2 weeks followed by oral administrate Clindamycin 300 mg every 8 h for the next 6 weeks. Dorsal approach to the elbow joint was used (a slight curved incision without cut of the flap). The distal part of the triceps brachii muscle was lost and muscle was contracted proximally without the possibility of reinsertion. Distal part of humerus and proximal parts of radius and ulna were inspected during the surgery. Ulnar nerve defect was found to be irreparable. The proximal part of the radius (the head and the neck with the length of 2.5 cm) was resected in order to achieve appropriate tonus of soft tissues for the endoprosthesis implantation. Humeral cavity was prepared. From the resected part of proximal radius, the radial head was resected and placed in the ulnar component to cope with the defect of the proximal ulna. Next, the ulnar cavity for the prosthesis insertion was prepared. Cemented Coonrad-Morrey prosthesis (Zimmer Biomet, Warsaw, IN, USA) composed of humeral component (extra small 4 inches) and ulnar component (extra small left long 4.5 inches) with the additional bone from radial neck was used (Fig. 4). The prosthesis was anchored by the vacuum mixed antibiotic mixed antibiotic loaded bone cement: Hi-Fatigue G bone cement (Zimmer Biomet, Warsaw, IN, USA). The soft tissues and skin were sutured without tension. The elbow was immobilized by cast fixation in 20°.

Postoperative period

The drains were removed on the second day. The serous secretion from the wound started on third postoperative day and continued indicating early infection (CRP 28 mg/L and WBC $12.0 \times 10^9/L$ at sixth postoperative day). One week after the implantation, the revision, debridement, haematoma evacuation and re-suture was performed. Microbiological findings were negative. Consequently, the wound was healed without secretion or inflammatory signs. Physiotherapy started after 2 weeks from the revision (and after removal of fixation). Five months after the surgery, X-ray showed good healing of the radial bone fragment on the ulnar component. The skin was healed with vital flap without the

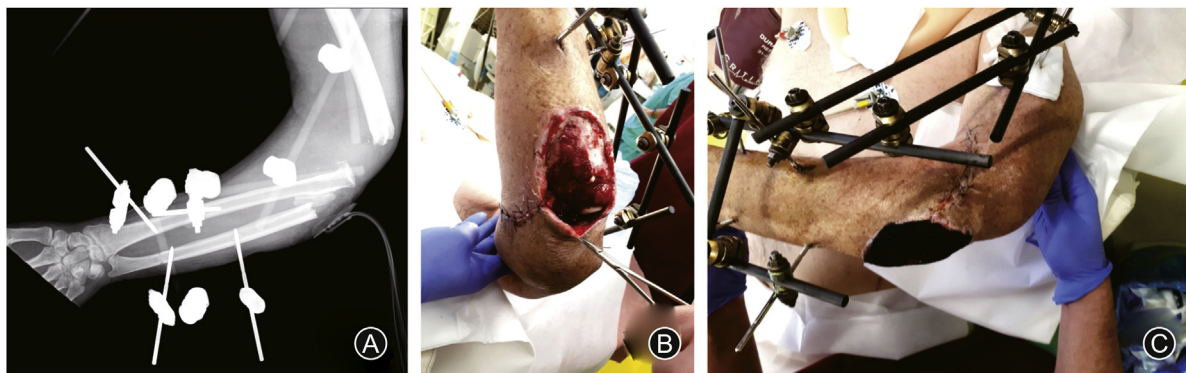


Fig. 2. The affected elbow 15 days after injury. (A) The X-ray of the injured elbow with the bone loss of distal humerus and the proximal ulna with external fixator and vacuum assisted closure system. (B) The image of soft tissues 15 days after injury with the large defect of the dorsal part of elbow, the head of radius is visible. (C) The image during vacuum assisted closure system placement, sutured wounds and good healing potential around the defect are visible.

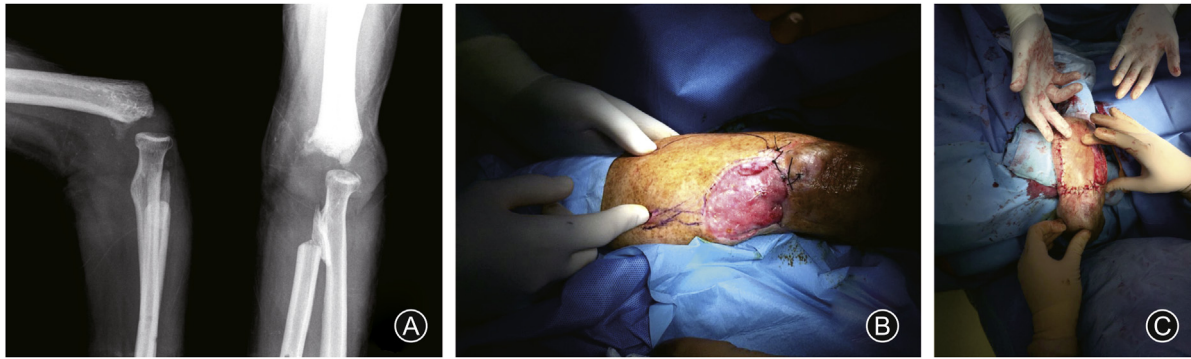


Fig. 3. The elbow without the external fixator 5 weeks after injury. (A) The X-ray after fixator extraction with defect of both humeral condyles and loss of the proximal ulna. (B) The image after vacuum assisted closure system removing, visible large, but clear soft tissue defect with granulations before the plastic surgery. (C) The image after fascia–cutaneous flap with the sufficient defect coverage.

signs of infection. Three years after injury, the patient was satisfied with the result, and worked as a courier. The elbow was stable, patient was able to perform an active flexion from 0° to 110° with full pronation–supination due to intact biceps brachii muscle.⁸ Extension was only passive by using the gravity due to the absent of extensor mechanism. Patient had permanent but tolerable ulnar neuropathy with inability to move with the fourth and the fifth finger. TEA was without the signs of loosening (Fig. 5). A permanent 5 kg weight bearing limitation is recommended.

The patient was informed that data from the case would be submitted for publication. The informed consent was obtained from the patient. This research has been approved by the institutional review board of the authors' affiliated institutions.

Discussion

This clinical case involves a patient who lost his elbow joint after sustained a complex open elbow fracture. We were confronted with large bone defect and soft tissue reconstruction.⁹

After initial fracture debridement and stabilization with external fixator, it became mandatory to find a treatment option that would allow restoring elbow function and stability. The primary treatment option of the complex elbow injuries was still osteosynthesis, but it was impossible in the case of considerable

bone loss (mainly intraarticular). Another procedure has been described in previous studies that immobilization in orthosis, arthrodesis of the elbow or amputation, both with very limited function and unsatisfactory aesthetic outcome.^{10,11} The implantation of cadaveric total elbow allograft with collateral ligaments was dismissed due to character of this unique case and no experience with this technique.¹² TEA was chosen as an alternative in order to achieve good functional result, elbow stability, and relieve of pain. The selection of TEA was based on review of state of art as some above-mentioned procedures resulted in poor functional outcome.^{6,10} Other authors published favourable results with TEA procedure.^{11,13}

Stability and life span of the prosthesis were taken as decisive factors. Patients with TEA have a life-long restriction placed upon them with limited weight-bearing.^{14,15} In the reported case, TEA has some relative contraindications like large open wound, severe functional impairment, relative younger patient and wound infection.⁷ Celli and Morrey¹⁶ reported revision rate of 22% in patients who received TEA younger than 40 years old. They reported TEA failure due to the loosening, polyethylene wear, deep infection and triceps weakness. They identified 55 patients who were 40 years old or younger treated with semi-constrained Coonrad–Morrey prosthesis. However, 93% of these with TEA had good or very good functional outcome during a mean follow-up of 99 months.

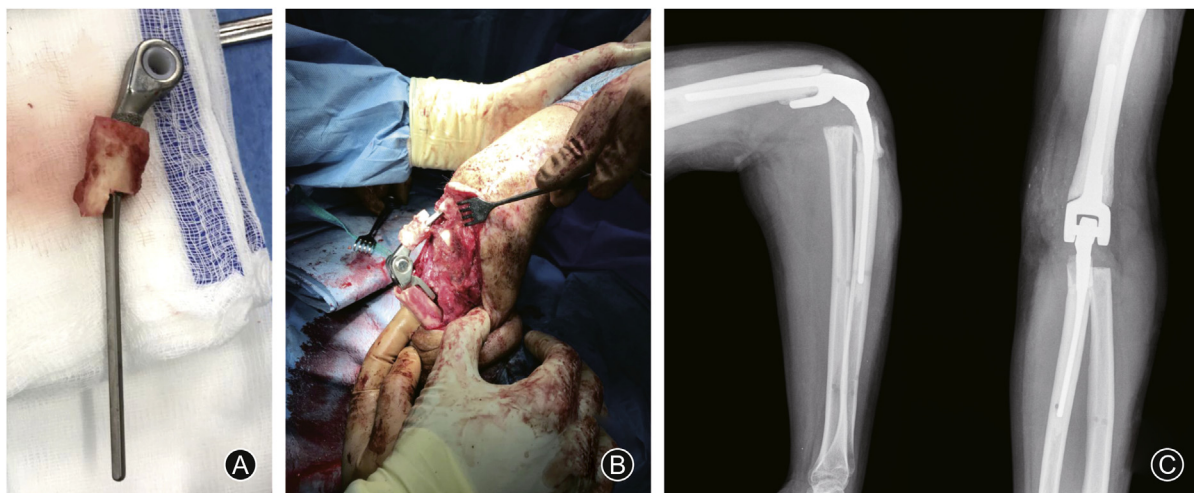


Fig. 4. The total elbow arthroplasty. (A) The image of the radius bone autograft implanted on the ulnar part of the artificial joint. (B) The image after total elbow arthroplasty implantation, radial bone graft on the ulnar component is visible. (C) The X-ray 1 week after the surgery.

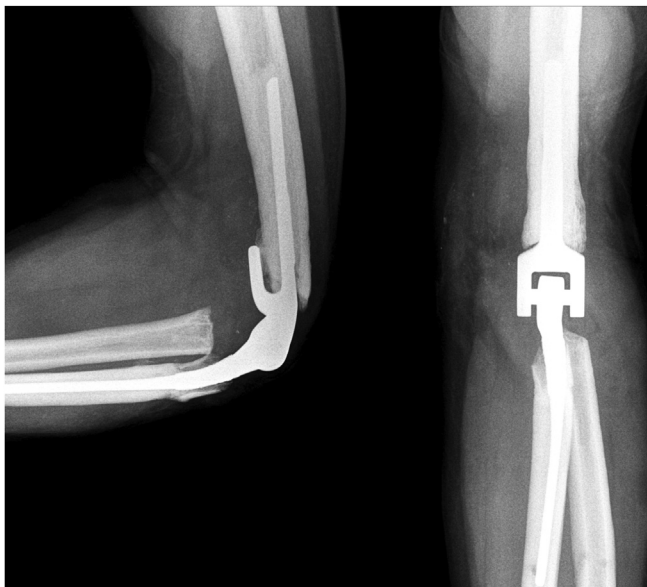


Fig. 5. The total elbow arthroplasty final result. The X-ray 3 years after the surgery, no signs of loosening, good bone integration of the radial graft.

There are only few studies about TEA in patients with comminuted elbow fractures.¹⁷ Linn et al.¹⁸ described the results and complications of elbow arthroplasty in open distal humeral fractures type GAI. The initial and radical debridement with irrigation was crucial. The average time from the injury to the TEA implantation was 6 days. There was no report of any infection in 7 patients. The results showed that, TEA was a treatment option in some open elbow fractures despite the risk of infection.

TEA implantation in type Gustilo-Anderson type III open elbow fractures were described in only few studies.

Franke et al.¹¹ described a case of 38 years old patient with elbow joint loss after blast injury. This patient was treated with the soft tissue coverage by musculocutaneous latissimus dorsi flap, temporarily external fixator and finally after 7 months with custom-made TEA. The patient achieved a good result after 2 years without infection.

Campos et al.¹³ published a case of type Gustilo-Anderson type III complex open elbow fracture with defect of distal humeral epiphysis, proximal ulnar epiphysis and with the skin injury of the dorsal part of the elbow. The 54 years old patient was treated by radical debridement, external fixator for 2 months and then TEA implantation 3 months after the injury. No complications were reported at 6 months follow-up. This second case corresponds to the case reported in this study in the type of injury and the treatment procedure. In the cases when the fracture or the bone defect goes above the olecranon fossa and the humeral shortening is up to 2 cm, the standard implant could be used. However, in the cases with the bone loss more than 2 cm above the olecranon fossa, the longer implant should be used. If the ulnar fracture or bone defect goes distally from the olecranon, the ulnar component with the longer stem is needed. In larger defects, the custom-made prosthesis should be considered.^{19,20} The loss of the humeral condyles does not affect the hand force when the Coonrad-Morrey TEA is implanted.¹⁷

TEA is a treatment option in the patients with non-reconstructable complex open elbow fractures with bone loss. The treatment is complex and included wound debridement and soft tissue reconstruction. Functional outcome may be limited. But in

our opinion, life quality with a sensitive and relative well functioning hand is better than with an exoprosthesis.

It is very important to understand the possible risk of TEA infection based on the primary wound management.

This protocol lead to a better postoperative management and prevents risk factors in Gustilo-Anderson type IIIB fracture treatment.

Funding

Nil.

Ethical statement

Every institution involved in this work has approved the human protocol for this investigation. Informed consent was obtained from the participant, and all investigations were conducted in conformity with ethical principles. All study participants provided informed consent, and the study design was approved by an ethics review board.

Declaration of competing interest

The authors state that there are no conflicts of interest regarding the publication of this article.

References

1. Yim GH, Hardwicke JT. The evolution and interpretation of the Gustilo and Anderson classification. *J Bone Joint Surg Am.* 2018;100:e152. <https://doi.org/10.2106/JBJS.18.00342>.
2. Primeau T, Beauchamp-Chalifour P, Pelet S. Complex case of open fracture dislocation of the elbow. *Case Rep Orthop.* 2019;2019:3495742. <https://doi.org/10.1155/2019/3495742>.
3. Regal G, Seekamp A, Blauth M, et al. Complex injury of the elbow joint. *Unfallchirurg.* 1996;99:92–99.
4. Steiert AE, Gohritz A, Schreiber TC, et al. Delayed flap coverage of open extremity fractures after previous vacuum-assisted closure (VAC) therapy – worse of worth? *J Plast Reconstr Aesthetic Surg.* 2009;62:675–683. <https://doi.org/10.1016/j.bjps.2007.09.041>.
5. Reichel LM, Wiater BP, Friedrich J, et al. Arthrodesis of the elbow. *Hand Clin.* 2011;27:179–186. <https://doi.org/10.1016/j.hcl.2011.01.005>.
6. Sala F, Catagni M, Pilli D, et al. Elbow arthrodesis for post-traumatic sequelae: surgical tactics using the Ilizarov frame. *J Shoulder Elbow Surg.* 2015;24:1757–1763. <https://doi.org/10.1016/j.jse.2015.07.030>.
7. Levin ES, Plotkin B. Elbow arthroplasty: from normal to failure. *Semin Musculoskelet Radiol.* 2019;23:141–150. <https://doi.org/10.1055/s-0039-1677698>.
8. Hrubina M, Behounek J, Skotak M, et al. The results of primary repair after distal biceps tendon rupture. *Acta Orthop Traumatol Turcica.* 2013;47:301–306. <https://doi.org/10.3944/AOTT.2013.2820>.
9. Hacquebord JH, Hanel DP, Friedrich JB. The pedicle latissimus dorsi flap provides effective coverage for large and complex soft tissue injuries around the elbow. *Hand.* 2018;13:586–592. <https://doi.org/10.1177/155894471772538>.
10. Kalicke T, Webber O, Backhaus M, et al. Salvage procedures of the elbow: alternatives to elbow arthroplasty. *Unfallchirurg.* 2010;113:990–995. <https://doi.org/10.1007/s00113-010-1901-x>.
11. Franke A, Bieler D, Hentsch S, et al. Reconstruction of an elbow joint after blast injury by arthroplasty with a custom-made modified total elbow prosthesis: a case report. *J Shoulder Elbow Surg.* 2014;23:e81–e87. <https://doi.org/10.1016/j.jse.2014.01.013>.
12. Ehsan A, Lee B, Itamura JM. Total elbow allografts with collateral ligament reconstruction for posttraumatic elbow injuries. *J Orthop Sci.* 2010;15:795–803. <https://doi.org/10.2174/1874325001711011353>. eCollection 2017.
13. Campos PM, Rosa B, Barros A, et al. Primary total elbow arthroplasty in treatment of complex elbow fracture: a case report. *Trauma Cases Rev.* 2015;1:1–3.
14. Beazley JC, Baraza N, Jordan R, et al. Distal humeral fractures – current concepts. *Open Orthop J.* 2017;11:1353–1363. <https://doi.org/10.2174/1874325001711011353>.
15. Mansat P, Bonneville N, Rongier M, et al. Experience with the Coonrad-Morrey total elbow arthroplasty: 78 consecutive total elbow arthroplasties reviewed with an average 5 years of follow-up. *J Shoulder Elbow Surg.* 2013;22:1461–1468. <https://doi.org/10.1016/j.jse.2013.07.042>.
16. Celli A, Morrey BF. Total elbow arthroplasty in patients forty years of age or less. *J Bone Joint Surg Am.* 2009;91:1414–1418. <https://doi.org/10.2106/JBJS.G.00329>.

17. McKee MD, Veillette CJ, Hall JA, et al. A multicenter prospective, randomised, controlled trial of open reduction – internal fixation versus total elbow arthroplasty for displaced intraarticular distal humeral fractures in elderly patients. *J Shoulder Elbow Surg.* 2009;18:3–12. <https://doi.org/10.1016/j.jse.2008.06.005>.
18. Linn MS, Gardner MJ, McAndrew CHM, et al. Is primary total elbow arthroplasty safe for treatment of open intraarticular distal humerus fractures? *Injury.* 2014;45:1747–1751. <https://doi.org/10.1016/j.injury.2014.07.017>.
19. Hackl M, Müller LP, Leschinger T, et al. Total elbow arthroplasty in traumatic and post-traumatic bone defects. *Ortopade.* 2017;71:944–947. <https://doi.org/10.1097/TA.0b013e31820efd69>.
20. Kiss J, Gulyás G, Mersich I. Reconstruction of an elbow destroyed in gas explosion with total elbow replacement: a case report. *Eur J Plast Surg.* 2001;24:47–51. <https://doi.org/10.1007/s002380000207>.