International Journal of Surgery Case Reports 86 (2021) 106356

Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.elsevier.com/locate/ijscr

Case report

Non-oncologic indication for elbow megaprothesis replacement: 2 cases report

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ARTICLE INFO

Keywords:
Total elbow replacement
Elbow mega-prothesis
Post-trauma sequelae

ABSTRACT

Introduction: Treatment of elbow bone defects is still a huge challenge in orthopaedic in order to restore the shape and function of the elbow joint. Bone defect reconstruction is very difficult due to biomechanical complexity of the elbow joint and the poor coverage tissue of this area, so mega-prothesis can be considered the most optimal solution in these cases.

Case report: We present two clinical cases of megaprosthesis elbow replacement for treatment of bone defects caused by sequelae of trauma. There is one case of 3 cm bone defect at proximal ulna and one case of 3 cm bone defect at distal humerus. In the 1st case, the elbow joint is fusioned and the second case, the elbow joint is degenerated totally after 3 previous surgery. We performed total elbow replacement with a customized mega-prosthesis for them. The Mayo elbow function assessment scale [1] pre-surgery was poor at 50 points. The average age is 35 years old. The mean post-operative follow-up time was 14 months. Range of elbow flexed motion was 135 degrees, both patients were maximally extension, the forearm pronation and supination were 90 and 75 degrees, respectively. The Mayo score is very good with 97,5 points. Both patients were completely satisfied with the postoperative results.

Conclusion: Our results show that megaprosthesis elbow replacement is a very effective option for cases large elbow bone defects due to trauma sequelae. However, careful preoperative preparation is required for the best outcome.

1. Introduction

For cases of bone defects in shaft bone, allograft or autograft can be used to reconstruct the bone defects. In case of bone defect involving the joint area, especially the joint is serious damaged, megaprosthesis can be considered the most optimal solution. According to the medical literature, megaprosthesis material began to appear in the 1940s with the main indication being treatment of bone defects caused by osteosarcoma [2]. The appearance of artificial joint megaprosthesis can be considered as a life-saving solution for many cases of large bone defects in the joint area. For cases of large bone defects around the elbow, the surgery is very difficult due to not only the biomechanical complexity of elbow joint but also poor coverage tissue is very close to vital vessels and nerves. The megaprosthesis joint is the most optimal choice to help restore the shape and function of the elbow for these cases [3,16]. Our report presents 2 clinical cases of extensive bone defects around elbow joint due to trauma sequelae which caused the patients unable to actively flex and extend the elbow. 1 case of distal humerus and 1 case of proximal ulna bone defects. Both cases were operated with a linked elbow megaprosthesis. The average follow-up time was 14 months with very good results in improving the shape and function of the elbow joint. This cases report was made according to the SCARE 2020 guidelines [4].

2. Case report

2.1. Case report 1

35 year-old female patient was suffered from left elbow injury 15

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https://doi.org/10.1016/j.ijscr.2021.106356
Received 16 July 2021; Received in revised form 23 August 2021; Accepted 23 August 2021
Available online 1 September 2021

year ago. The patient has been operated 2 times. The first time was internal fixation, then the bone was non-union at the distal humerus. The second time was also internal fixation with bone graft and elbow adhesion release. After this second surgery, the patient's elbow is still unable to flex and extend on its own so far. The patient came to us in the following condition: left elbow completely unstable, unable to actively flex and extend the elbow, forearm pronation and supination 70 degrees and 60 degrees, respectively. The elbow function score according to Mayo scale was 45 points, at a poor level and severely affect the activities and the quality of life. There is a complete adhesion figure of humeroulnar joint and distal humerus bone defect on X-rays (Fig. 1) and 3D CT scans before surgery (Figs. 2, 3).

We decided to perform a linked megaprosthesis total elbow arthroplasty, personalized 3D design based on the patient's computed tomography scans, with an extra bone was made of Titanium alloy (manufactured by Chunli Medical, Beijing, ChinaN) for the bone defect of distal humerus (Fig. 5a, b). Before surgery, we printed 3D plastic of injury bones with the same size to the patient's real bone for templating and planning the surgery more precisely (Fig. 4a, b).

The patient was under general anesthesia, in decubitus position. We make an incision on the back of elbow joint according to old scar, release the soft fibrous adhesion, expose the ulnar nerve. Then exposing the position of distal humerus bone defect, dissecting from this position to the attachment of triceps tendon, half splitting the triceps tendon to retain the attachment point and revealing the elbow joint: the elbow was completely adhesive in a block, 3 cm of distal humerus bone defect. We performed distal humerus shaping, humeral medullary reaming, half splitting the triceps tendon close to the attachment point, proximal ulna shaping, and ulnar medullary reaming. Then, place the artificial joint with cement of the humerus and ulna. Check immediately intra-operation: 120 degrees of flexion, 0 degree of extension, 80 degrees of pronation and 70 degrees of supination. We actively moved forward the ulnar nerve to prevent compression, sutured the triceps tendon and close the incision. The patient had postoperative radiograph show that the implants are anatomically correct surficial image (Fig. 6a, b).

The patient was practiced passive flexion and extension on 2nd, passive pronation and supination on 5th, active motion on 10th and strength training on 14th after surgery.

The patient was scheduled for a follow-up every 2 weeks. 13 months after surgery: the surgical scar was completely healing, 130 degrees active flexion, 0 degrees active extension, 90 degrees active pronation and 70 degrees active supination. Mayo function score reached an excellent level at 95 points, the patient was able to return to normal daily activities.

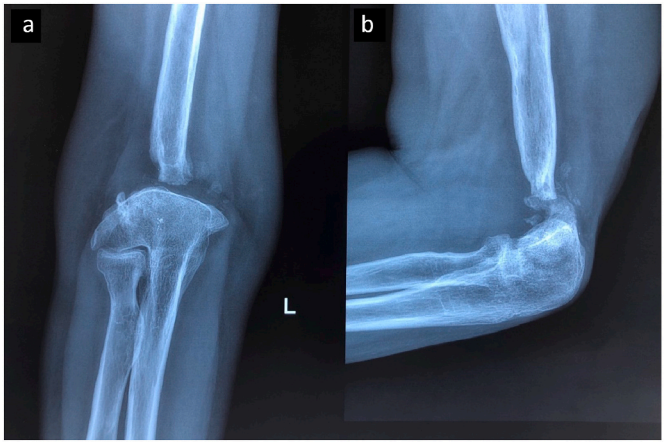


Fig. 1. Complete adhesion figure of humeroulnar joint and distal humerus bone defect on AP view (a) and lateral view (b) X-rays before surgery.

2.2. Case report 2

35 year-old female patient was suffered from moto-bike accident 30 months ago, had a Monteggia fracture. The patient was treated at another hospital before coming to us and she was operated 4 times: ORIF, bone graft, clean the inflammation, antibiotic cement then removes it. After this treatment, the patient did not have signs or symptoms of inflammation, inflammation investigation also returned to normal but the active range of elbow motion was lost. The patient came to us in the following condition: the elbow joint is unstable, losing active elbow movement, pronation 70 degrees and supination 50 degrees. The joint function on the Mayo scale at poor level is 55 points, severely affecting the quality of life. There is a figure of anterior radial head dislocation, joint adhesion and proximal ulna bone defect (Figs. 7, 8).

We decided to perform a linked megaprosthesis total elbow arthroplasty, personalized 3D design based on the patient's computed tomography scans, with an extra bone was made of Titanium alloy (manufactured by Chunli Medical, Beijing, China) for the bone defect of proximal ulna (Fig. 9a, b).

The position and skin incision are the same as the case report 1. Exposing the position of bone ulna defect, revealing 3 cm of bone defect and elbow joint. The elbow joint is completely osteoarthritis, radial head dislocation, completely deformity.

Dissecting from the attachment of triceps tendon, half splitting the triceps tendon to retain the attachment point, radial resection, humeral medullary reaming. Drill and ream the ulnar medullary. We took advantage of the position of the ulna bone defect to drill a hole in the olecranon so that the artificial joint could fit through this hole. Then, place the artificial joint with cement into bone marrow. Check immediately intra-operation: 140 degrees of flexion, 0 degrees of extension, 80 degrees of pronation and 70 degrees of supination. We actively moved forward the ulnar nerve to prevent compression, sutured the triceps tendon and close the incision. The patient had postoperative radiograph show that the implants are anatomically correct surficial image (Fig. 10a, b).

The patient was scheduled for a follow-up every 2 weeks. 15 months after surgery: the surgical scar was completely healing, 140 degrees active flexion, 0 degrees active extension, 90 degrees active pronation and 80 degrees active supination. Mayo function score reached an excellent level at 100 points, the patient was able to return to normal daily activities (Fig. 11a, b, c).

3. Discussion

Megaprosthesis began to use in the 1940s [2], but the term "megaprosthesis" was first used at the International Conference on Design and Application of Artificial Materials in Tumor Pathology, held at the Mayo Clinic in 1981 [7]. Indications for the use of megaprosthesis joints are still being discussed, but most authors support the use of this material in cases such as: post-operative of removing bone tumor around the joint, in cases of long bone loss or very poor bone quality cannot be applied other surgical method, bone defect treatment due to trauma sequelae or non-healing bone after surgery [8,10]. In which, it can be see that megaprosthesis joint arthroplasty after operating to remove bone tumours around the joint is the most common. In addition, mega-prothesis can also be used in the case of joint replacement when the previous joint replacement has failed [9]. The authors believe that the above cases had a large segment of bone defect as well as the surrounding soft tissue is very poor or poor quality of bone, so it is difficult to use other methods to be effective. Megaprosthesis elbow arthroplasty is the most optimal solution to help store the anatomical and function of elbow joint. Our 2 patients were performed a linked megaprosthesis total elbow arthroplasty, personalized 3D design based on the patient's computed tomography scans data.

Many authors around the world believe that cases of severe sequelae after elbow trauma such as severe elbow degeneration, completely

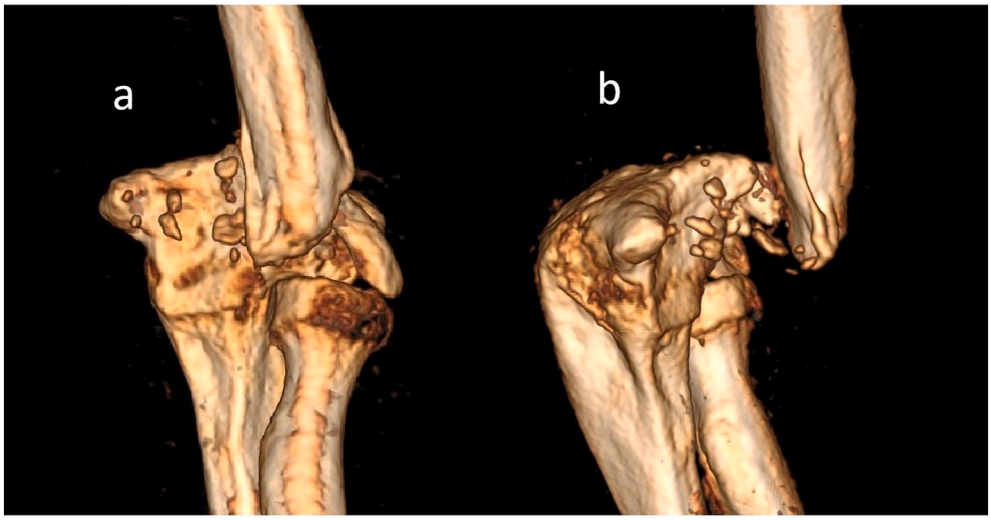


Fig. 2. Complete adhesion figure of humeroulnar joint and distal humerus bone defect on 3D CT scans before surgery in posterior view (a) and medial view (b).

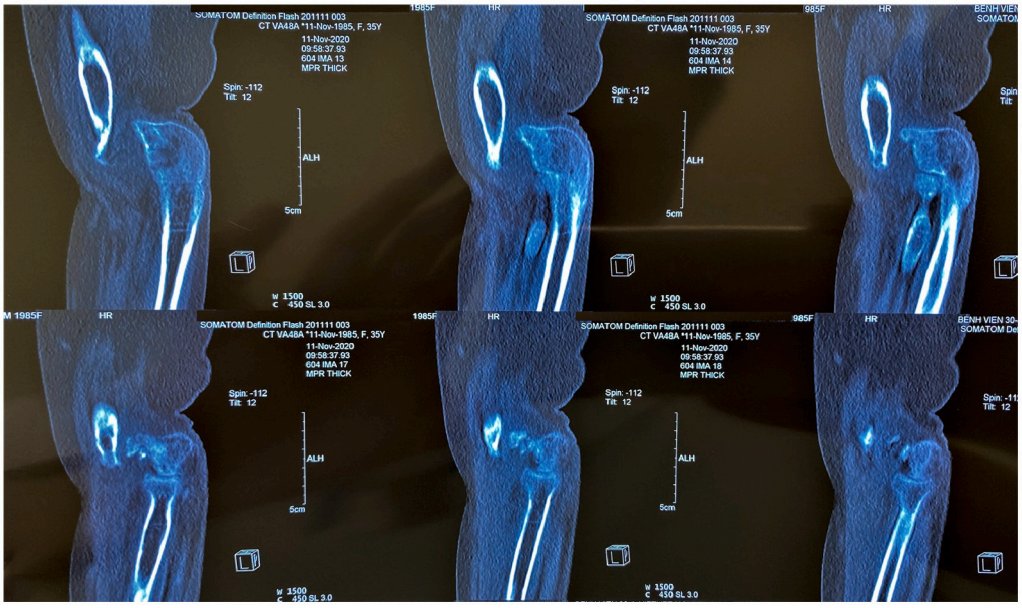


Fig. 3. Complete adhesion figure of humeroulnar joint and distal humerus bone defect on sagittal plane CT scans.

elbow stiffness, elbow adhesion, distal humeral non-union or bone defect, elbow arthroplasty is the best way to restore range of motion of the elbow joint. These authors also have clinical reports with very good results of elbow arthroplasty [5,6]. Our 2 patients were suffered from megaprosthesis elbow arthroplasty for distal humerus and proximal ulna with 14 months follow-up and no distal complication.

The reports of megaprosthesis elbow arthroplasty are mainly around elbow osteosarcoma removing, very few reports about bone defect due to trauma sequelae [3,12–15]. Our two patients were severe sequelae after trauma causing 3 cm bone defect (distal humerus and proximal ulna). Using Allograft was also considered but the risk of graft failure and infection is very high because the soft tissue of both patients is not good due to many times of surgery, moreover the elbow is completely adhesive. Therefore, in our opinion, megaprosthesis elbow arthroplasty is the optimal solution to restore elbow joint function and minimize surgical complication for these two patients.

Many authors in the world also claim that reconstructive surgery for elbow joint is very difficult due to mechanical complexity and soft tissue coverage in cases of large bone defect around the joint. For these cases, the megaprosthesis joint is the most optimal choice to help restore the shape and function of the elbow compared with other methods [3,12–15].

The authors also believe that megaprosthesis elbow arthroplasty is a very reliable and effective choice in treatment of large bone defect around the elbow joint, helping to reduce the pain and rehabilitate the function of elbow joint in a best way. The complication rate with megaprosthesis joint is lower than other methods such as bone graft and other composites [3]. Rodolfo Capanna et al. reported 36 cases of megaprosthesis elbow arthroplasty. Of these, 31 patients were suffered from elbow joint arthroplasty after bone tumor resection and 5 patients were suffered from elbow joint arthroplasty due to failure from the primary arthroplasty [3]. The average follow-up time after surgery was 25 months, Mayo average score was 77,08 points, a good score in terms of elbow joint function. Marcel-Philipp Henrichs reported that megaprosthesis arthroplasty for distal humerus in 12 patients after osteosarcoma resection, the survival rate of artificial material was 82% at 2 years and 64% at 5 years [16]. 2 patients in our report followed to the present time (average 14 months) have not recorded any complications such as

Fig. 4. a. 3D plastic model of injury bones with the same to the patient's real bone. b. 3D plastic model with the same size to the megaprosthesis of patient.

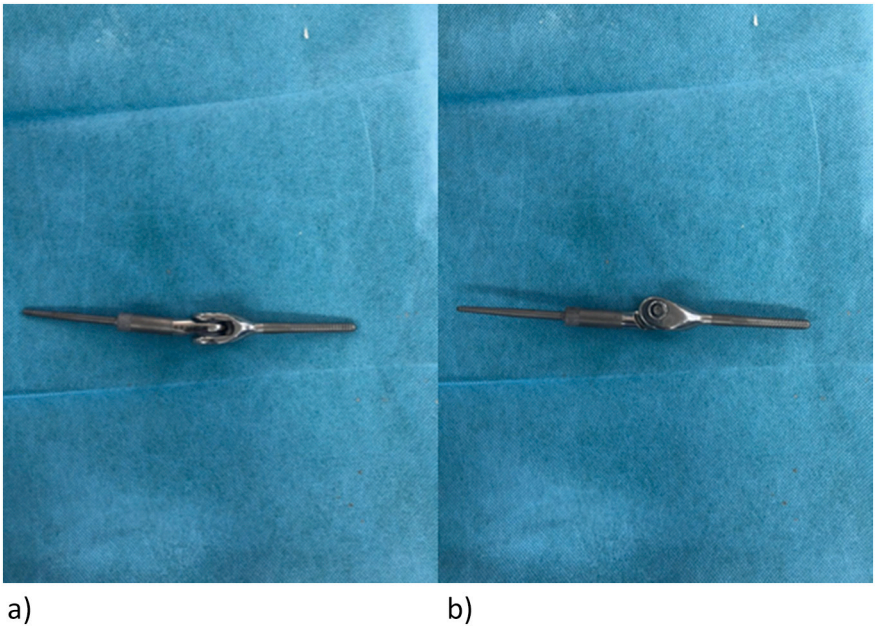


Fig. 5. a, b: A linked megaprosthesis used in the surgery.

loosing prosthesis, infection or nerve injury. There is only one case of temporary radial nerve damage but fully recovered after 2 months. We will continue follow 2 patients in the future because the loosening complication usually occur after a long follow-up period, as mentioned and recommended by other authors [3,16].

Although this is a very good option to help store shape and function in large bone defect or severe damage of elbow, but the complication rate after megaprosthesis elbow arthroplasty has also been reported by many authors. The authors believe that because these patients have severe bone and soft tissue injury, so there is a high risk of postoperative complications such as artificial loosening, infection, radial and ulna nerve damage. In 2011, Philipp T. Funovics el al reported the results of 52 modular megaprosthesis in 52 patients after resection of osteosarcoma and very severe elbow osteoarthritis, resulting in 34 patients without complication, 18 patients had to repair due to complications related to artificial joint, no wound healing, radial and ulna nerve palsy [15]. Rodolfo Capanna reported megaprosthesis in 36 patients, there were 6 complications, including 2 cases of irreversible radial nerve injury, 1 case of temporary radial nerve injury, 1 case of ulna nerve damage, 1 case of artificial loosening and 1 case of deep infection leading to artificial removal. [3]. Our patients recorded an early radial nerve injury complication in a patient with megaprosthesis elbow arthroplasty for distal humerus bone defect. The 2nd post-operative day showed loss of wrist and finger extensor, but did not affect the elbow flexion and extension. The symptoms disappeared 2 months after surgery, the patient was able to extend the wrist and finger normally. This complication occurred due to over-stretching the radial nerve after putting artificial joint because the soft tissue had contracted for a long

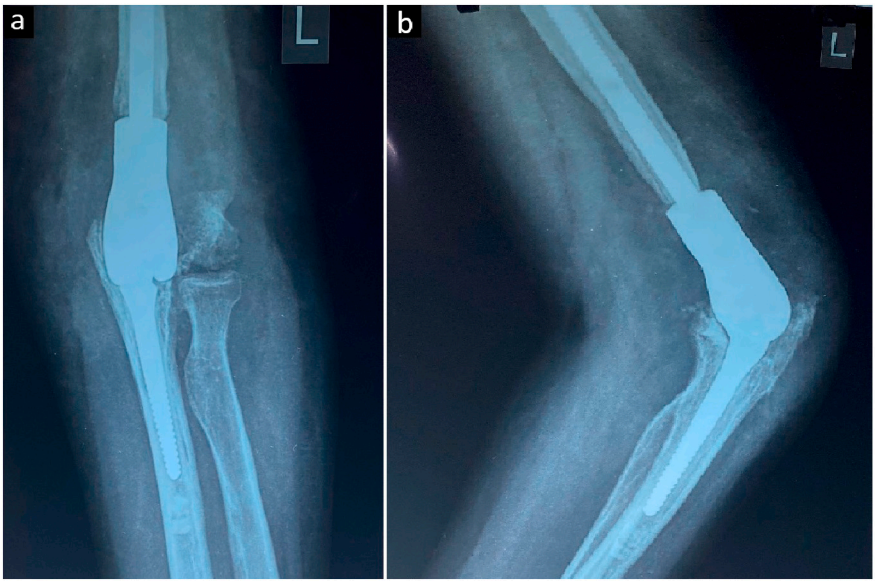


Fig. 6. a, b: Xrays after surgery.

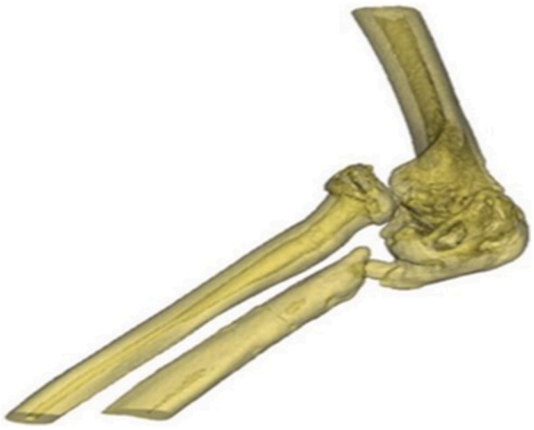


Fig. 7. Joint adhesion and proximal ulna bone defect on CT scanners.

time of surgery, but the symptoms of radial nerve palsy was gone after 2 months. Complications of radial nerve are very rare, authors around the world also rarely encounter this complication. T. Waitzenegger and P. Mansat pointed out that 2 cases of radial nerve injury are caused by the leakage of cement through the bone causing heating and irritation of the radial nerve and another cause by stretching or contraction the radial nerve [11].

Regarding the incision and dissection, we still start from the behind of elbow to avoid pressure point, revealing the ulna nerve, protect the nerve during surgery and actively move the ulna nerve bed. The authors in the world also mentioned a lot of nerve damage after elbow replacement surgery, so we actively moved forward the ulnar nerve to prevent compression [17].

There are many different ways of exposing the elbow joint from splitting the triceps tendon in half, removing the triceps tendon from one or both sides and completely dissecting the attachment point then suturing through the bone with super-strong sutures to cut the olecranon [18]. However, both of our surgeries are customized according to the lesion making the process easier to access. In the 1st case, the elbow joint was completely adhesive in a block, the joint gap was no longer invisible and large distal humerus bone defect. Therefore, we exposed to the position of bone defect, from this site dissected to the point of attachment of triceps tendon and split the triceps tendon in half but retain the attachment point. Although leaving a tendon attachment point makes bone cutting and joint fitting somewhat more difficult, the patient can practice flex and extend the elbow soon without worrying of tendon rupture at the attachment point. The 2nd case, we customized according to lesion and do not follow the classic incision [18], the elbow joint is not adhesive to a block, but the distal humerus also was adhesive to proximal ulna. When exposing to the position of ulna bone defect, we flipped this adhesive block to reveal the elbow joint without cutting the olecranon, moreover we customized it by creating a hole at the position of the adhesive block to fit ulnar component of the artificial joint. Thus, not only cutting the olecranon but also keeping the attachment point of triceps tendon. In both cases, the attachment of triceps tendon was preserved, which is the most important anatomical structure in the extensor mechanism of the elbow. Therefore, helping patients to practice and rehabilitate immediately after surgery, return to normal activity as soon as possible.

Our 2 clinical cases are both cases of severe bone and soft tissue damage in the elbow area, so there are many risks in surgery. Therefore, we had a very thorough preoperative preparation to minimize the risk intraoperative and postoperative complications. The 3D CT scanners and measure the parameters before sugery is obligatory, personalized joint design according to the injury is also based on the parameters measured on the 3D CT scanners. We also created 3D printed model the bone lesions to resemble the actual's patient injury to help make preoperative calculations as accurate as possible. During surgery, we try to protect the soft tissue as much as possible, because the more soft-tissue we keep, the less chance of infection and distribute some of the load on the artificial joint, thereby reducing the risk of artificial loosening. In addition to temporary radial nerve injury, we did not recognize any complications up to now, elbow range of motion improved very well, both patients return to normal daily activities and completely satisfied with the results.

4. Conclusion

Megaprosthesis elbow arthroplasty is an optimal option to help restore the anatomical and function of elbow joint in these cases of large bone defect and severe damaged joint caused by trauma sequelae. After surgery, there may still be risks such as infection, loosening of artificial joint or nerve injury. Therefore, to have good results and minimize complications, it is necessary to have a thorough pre-operative and plan.

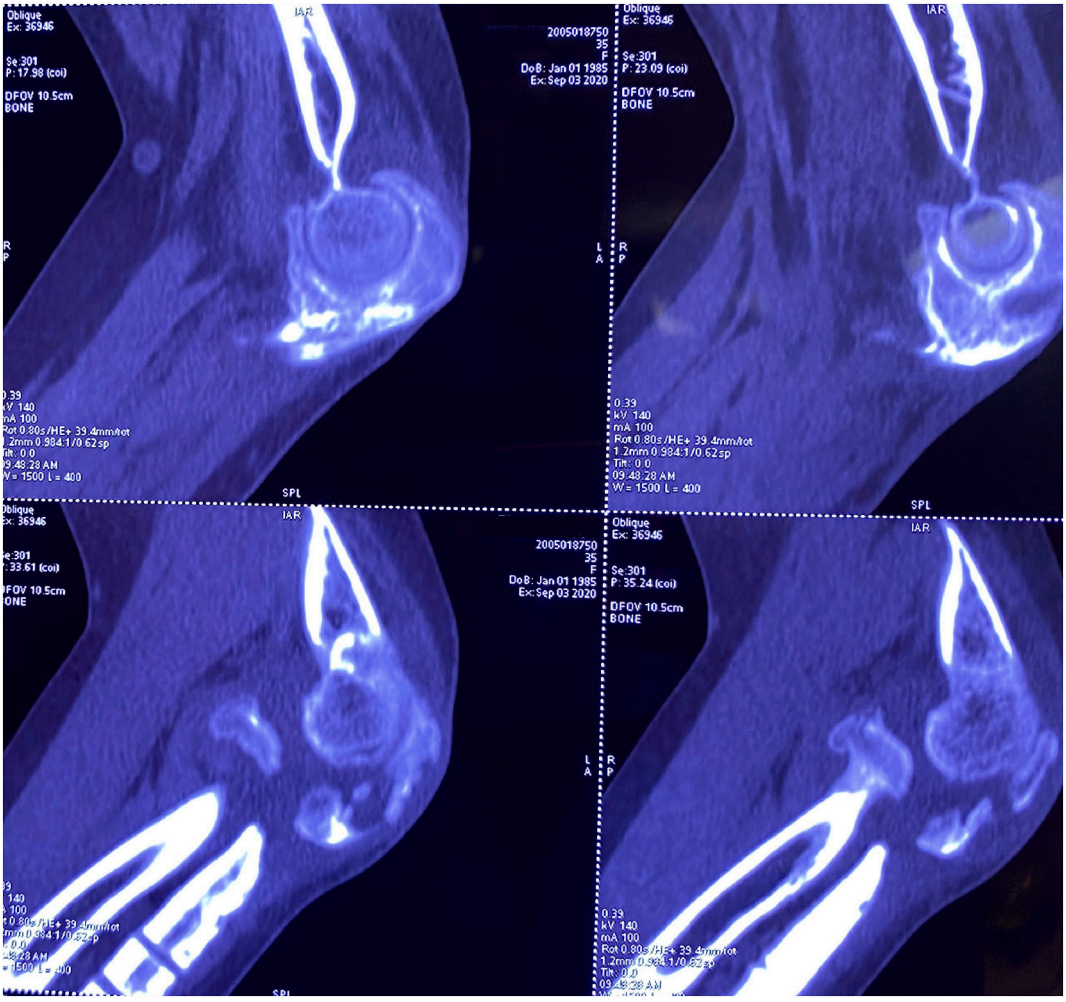
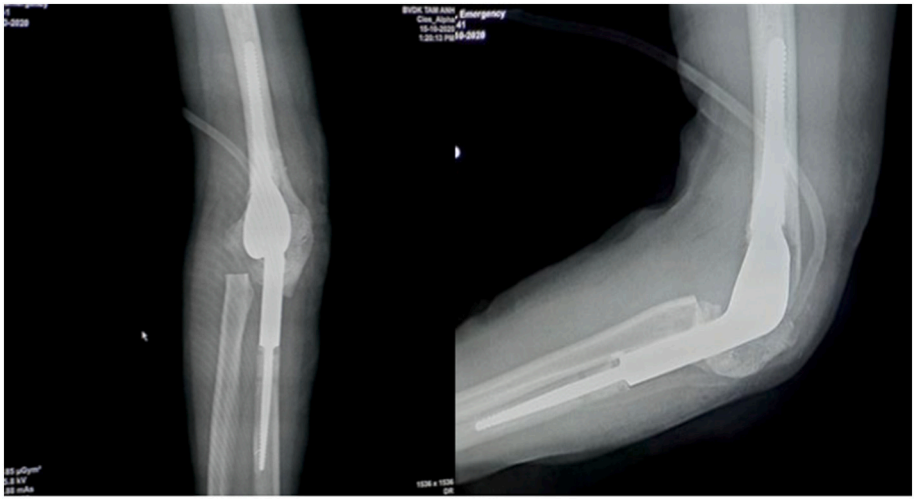


Fig. 8. Joint adhesion and proximal ulna bone defect on sagittal plane CT scans.

a) b)

Fig. 9. a, b: A linked mega-prothesis.



a) b)

Fig. 10. a, b: X-rays after surgery.

a) b) c)

Fig. 11. a, b, c: 15 months after surgery.

Sources of funding

The authors declare that sponsors had no such involvement.

Ethical approval

The procedures used in this study inhere to the tenets of the Declarations of Helsinki.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request. The patient received an explanation of the procedures and possible risks of the surgery, and gave written informed consent.

Author contribution

DTT contributed to performed the operation, revising, and approval for publishing.

QT, NVT, SNTQ contributed to assist the operation, data collection, analysis and interpretation, manuscript drafting.

MHN, HPT contributed to data collection, analysis and interpretation, manuscript drafting.

Registration of research studies

Not applicable.

Guarantor

DTT is the guarantor of this manuscript.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Declaration of competing interest

We declare that we have no known competing financial interests or personal relationships with anyone that could have appeared to influence the work reported in this paper.

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