CASE REPORT
KAZUISTIKA

Successful Total Elbow Replacement after Septic Arthritis with *Staphylococcus aureus* – a Case Report and Review of the Literature

Úspěšná náhrada loketního kloubu po septickém zánětu způsobeném *Staphylococcus aureus* – kazuistika a přehled literatury

M. RUPP, J. MIKA, C. BIEHL, C. HEISS, V. ALT

Department of Trauma, Hand and Reconstructive Surgery, University Hospital Giessen-Marburg, GmbH, Campus Giessen, Germany

SUMMARY

Septic arthritis of the elbow seems to be a contraindication for total elbow arthroplasty (TEA). We here describe a 65-year-old male, American Society of Anesthesiologists (ASA) class 3 – patient, with a severely destructed right elbow due to septic arthritis with *Staphylococcus aureus*. His treatment consisted of multiple irrigation and debridement procedures including resection of the distal humerus, soft tissue coverage by local rotational flap and the use of a gentamicin-vancomycin loaded PMMA spacer, i.v. and oral antibiotics. After eradication of infection, a constraint cemented TEA could then successfully be performed eight months after the initial surgery and twenty-five weeks after the last debridement procedure. Twenty-one months after the TEA, the patient remained infect free and shows excellent functional results: Disabilities of the Arm, Shoulder and Hand (DASH) score: 38.3, Broberg and Morrey score: 91/100, Mayo elbow score: 95/100.

To the best of our knowledge this is the first case in the literature that demonstrates TEA after septic elbow arthritis with *Staphylococcus aureus*. Although TEA is known as a typical surgical procedure with a low volume in numbers and higher complication rates, such as elevated infection rates compared to other types of arthroplasty, septic arthritis with *Staphylococcus aureus* can successfully be performed after eradication of the infection and targeted antibiotic therapy.

Key words: total elbow arthroplasty, total elbow replacement, septic arthritis, *Staphylococcus aureus*.

INTRODUCTION

Compared to the hip and knee, total elbow arthroplasty (TEA) is a rare surgical procedure. Its annual incidence is 1.4 per 100,000 compared to incidence rates of total hip replacement as 70 to 99 in 100,000 of the population (10, 25). In other words: 3136 TEAs within 5 years vs. about 700,000 total knee arthroplasties annually in the United States describe the low volume in numbers of TEA (27). Unlike in hip and knee arthroplasty primary osteoarthritis is not the main indication for total elbow arthroplasty. Because of better medical treatment for rheumatoid arthritis due to the improved medical management with disease-modifying antirheumatic drugs, the number of annually performed TEAs decreases in patients suffering from rheumatoid arthritis. Nowadays, posttraumatic sequelae with posttraumatic osteoarthritis after complex elbow fractures are the main reason for TEA and lead to an overall increase in numbers (12). Further indications for elbow arthroplasty are distal humerus non-unions, primary osteoarthritis, haemophilic arthropathies and reconstruction after tumor resection (31).

Complication rates regarding TEA are much higher compared to frequently performed total hip and knee arthroplasty. A complication rate in TEA up to 43% was described in 1996 (17). Although advances in prosthetic design and surgical techniques have been made since the 1990s the complication rates remain high. A surgical revision rate of 69% for any reason within 5 years after TEA has been reported for patients with rheumatoid arthritis (4). Toulemonde and colleagues showed a complication rate of 37% at a 5 years follow-up average (16). Typical complications of TEA are ulnar neuropathy and weakness of the triceps muscle. In addition, periprosthetic joint infections play a major role as a reason for revision surgery in TEA. The incidence of elbow periprosthetic joint infection is reported to be in the range 3–11% compared to an overall incidence range of 2–2.4% in hip and knee arthroplasty (6, 11). Within this framework, avoidance of TEA after septic arthritis seems to be a wise surgical decision. However, alternatives like salvage procedures such as resection arthroplasty or elbow arthrodesis (EA) are accompanied either with instability

combined with loss of strength or loss of motion in case of an arthrodesis.

Here we demonstrate a case of a patient suffering from septic arthritis with *Staphylococcus aureus*, with relevant comorbidities, such as diabetes mellitus type 2, successfully treated with TEA after eradication treatment of the infection.

Case report

A 65-year-old man presented with a swollen, red and painful right elbow in our emergency room. The ASA class 3-patient suffered from diabetes mellitus type 2, obesity, congestive heart failure, coronary artery disease, atrial fibrillation, hereditary factor VIII deficiency and von Willebrand's disease. Clinical examination showed purulent discharge above the bursa olecrani. Due to enormous pain, the patient was not able to move his elbow. X-rays of the elbow revealed severe destruction of the elbow joint with calcification of the surrounding soft tissue (Fig. 1). Septic arthritis of the elbow joint was diagnosed, and an excision of the fistula, total synovectomy, extensive surgical debridement, irrigation with polyhexanide, insertion of gentamicin-polymethyl-metacrylate beads and an immobilization of the elbow joint by insertion of an external fixation device was performed. Calculated intravenous antibiotic therapy was started with Unacid® 3 g (2 g Ampicillin, 1 g Sulbactam) three times a day. The microbiological isolation of *Staphylococcus aureus* from tissue samples obtained during surgery confirmed the septic elbow arthritis. The histological description of a fibrinous-purulent synovialitis matched the clinical aspect of the putrid joint infection. Throughout the following treatment a total of 8 surgical revisions were necessary within 66 days. Due to enormous swelling, of the elbow after initial surgery a temporary skin replacement using a polyvinyl acetate sponge (Coldex®, Velo Medizinprodukte GmbH, Sengenthal, Germany) was applied during the first revision surgery. Irrigation with polyhexanide, jet lavage and surgical debridement of the elbow joint including resection of infected bone was performed each time. Furthermore, local drug carriers with gentamicin as a local antibiotic as well as further skin replacement sponges were exchanged on a regular base. Soft tissue coverage was achieved at the medial aspect of the elbow joint by local flap and eradication of the infection could be achieved. Following temporary arthrodesis with an external fixator, a cemented constraint elbow prosthesis (Discovery®, Zimmer Biomet, Warsaw, Indiana, USA) was implanted eight months after the initial surgery and twenty-five weeks after the last debridement procedure. After implantation of the elbow prosthesis antibiotic therapy was perioperatively started with cefazolin 2 g three times a day and rifampicin 300 mg twice a day. After administration of those intravenous antibiotics for 1 week, the therapy was switched to oral antibiotics using ciprofloxacin 500 mg twice a day and rifampicin 300 mg twice a day for 4 weeks as prolonged antibiotic therapy to avoid a biofilm. With the above described therapy, the wound healing showed no abnormalities.

Fig. 1. Preoperative X-rays of destructive elbow joint arthritis in lateral (A) and anterior-posterior (B) projection.

Fig. 2. Postoperative X-rays of the elbow prosthesis. 2 months after implantation no radiological sign of loosening is detectable in anterior-posterior (A) and lateral (B) projection, signs of a dislocation of the olecranon were visible, though.

Fig. 3. Postoperative X-rays of the elbow prosthesis 21 months after implantation. No radiological sign of loosening is detectable in anterior-posterior (A) and lateral (B) projection. Unchanged signs of non-union development at the olecranon tip.

Eight weeks after TEA the patient had to be readmitted with a wound dehiscence requiring surgical revision. Fortunately, just a superficial wound dehiscence was

Fig. 4. Flexion (A) and extension (B) of the right elbow 21 months after TEA.

Table 1. Criteria for diagnosis of septic arthritis (15)

(a)	organism isolated from the joint
(b)	organism isolated from elsewhere in context of a swollen and warm joint
(c)	histological and radiological evidence of infection
(d)	turbid fluid aspiration in context of a possible joint infection

Table 2. Gächter classification of septic arthritis (14)

Stage I	turbid synovia, inflammatory redness of the synovial membrane, possible petechial hemorrhage no radiological changes
Stage II	Severe inflammation with fibrin deposits, pus no radiological changes
Stage III	thickening of the synovial membrane, articula compartment formation, still no radiological changes
Stage IV	extensive pannus formation, radiologically detectable subchondral osteolysis, bony erosions and cysts formation

found without an involvement of the deeper soft tissue layers or of the prosthesis and the wound could be closed after skin debridement.

Twenty-one months after implantation of the Discovery® elbow prosthesis the patient remained infection-free. Patient based scores such as the DASH (2), Broberg and Morrey score (9) as well as the Mayo elbow score (1) showed excellent results. The clinical examination showed irritation free scars without any neurovascular irregularities of the arm. Sensation of the arm was entirely intact except of the area in direct vicinity to the former incision. The range of motion of the elbow was extension/flexion 0–20–100° (Fig. 4), pronation/supination 90–0–70°. There was neither subjective nor objective joint instability. The patient mentioned a mild loss of strength in his forearm compared to the other side. The following scores were found: Mayo elbow score 95/100 points, Broberg and Morrey score 91/100 points, DASH score 38.3 points. X-rays showed the TEA without any radiological signs of implant loosening after 2 months (Fig. 2) and 21 months, respectively (Fig. 3). Signs of a non-union of the olecranon tip were visible.

DISCUSSION

Septic arthritis was diagnosed due to clinical and radiological findings. Purulent discharge and clinical signs of local infection lead to the early diagnosis using criterias described by Newman in 1976 (Table 1) (15). Mortality in patients suffering from monoarticular sepsis seems to be around 11% (13), permanent joint damage is reported in up to 50% (24). Hence, early revision surgery combined with antibiotic therapy was carried out immediately.

Gächter classified septic arthritis in a four stage manner (Table 2) (14). Based on this classification a stage dependent treatment of septic arthritis was established (30). If Gächter type I–III septic arthtitis is treated by arthroscopic irrigation, debridement and antibiotic

therapy, cartilage and joint preserving therapy is intended. Unfortunately, antiseptics such as polyhexanide, hydrogen peroxide and taurolidin have besides their broad antimicrobial range and high potential for defeating infections in septic surgery an apoptosis inducing effect in chondrocytes (29). Therefore, use of antiseptics in joint preserving therapy is not recommended (30). The lack of antiseptics without cartilage damaging effects, might be one reason for the reported permanent joint damage up to 50%. However, the reason for high morbidity and mortality rates might be infection with *Staphylococcus aureus* itself. Independent of age, path of infection and other risk constellations *Staphylococcus aureus* is the most common bacterium in septic arthritis (24). Moreover, *Staphylococcus aureus* is characterized by certain surface proteins (protein A, collagen adhesion (Cna), clumping factor (ClfA), which can explain joint affinity. High morbidity and mortality are attributed to such virulence factors (20).

Because of clinical signs of infection and radiological signs of joint destruction of a Gächter stage IV septic arthritis, open revision surgery was necessary in our case. Radiological evidence of joint destruction indicated surgical therapy. Complying with principles of septic surgery in a curative approach, radical debridement, soft tissue coverage and reconstruction as well as immobilisation through temporary arthrodesis combined with local and systemic antibiotic therapy was carried out (26). Antibiotic anti-biofilm therapy was administered as described for endoprosthesis reimplantations after periprosthetic joint infections with antibiotic sensitive *Staphylococcus aureus* (22).

After infect eradication three orthopaedic treatment principles – arthroplasty, arthrodesis and resection arthroplasty – were left over as surgical treatment opportunities.

Due to the high prevalence of postoperative complications in TEA, septic arthritis of an elbow joint seems to be a contraindication for TEA (32). In the literature, several

studies show good outcomes after TEA in primary and revision elbow arthroplasty (16, 19). However, comparison of the published data is difficult due to many reasons: different indications for TEA, different kind of elbow prosthesis, different follow-up periods, different end points, different scoring systems. Nevertheless, the result of our 21 months follow-up with a very satisfied, pain free patient as well as good clinical results and scores is consistent with a high satisfaction rate of 90%, an increase in pain free patients from 7% to 63% and an improved range of motion up to an extension-flexion-arc of 93° and a supination-pronation-arc of 113° in a prospective clinical outcome study regarding the Discovery® elbow prosthesis for different indications (28). Mid-term outcome of TEA in 21 patients suffering from rheumatoid arthritis after a mean follow-up of 64 months are similar. The mean DASH score improved after TEA from 72.3 to 46.8, mean flexion from 96.9° to 128.1°, mean extension lag from 37.3° to 24°. However, it has to be taken into account that patients were not infected and without previous surgeries (4).

The satisfying outcome after TEA was not compromised by the patient's complex medical condition. Concerning risk factors for TEA progressed diabetes mellitus, obesity and male sex were proven as such (5, 8, 18).

If surgeons assess the risk of TEA as too high, other options for the patients have to be reflected. EA as a salvage procedure after infection of periprosthetic elbow infections have also a high complication rate and often no confirmed union (21). Furthermore, the tradeoff for functional activity and pain relief is loss of motion, which cannot be compensated by shoulder and wrist joints (7). Interestingly, conversions of EA to TEA are reported showing a good clinical outcome even after EA for 7 and 30 years, respectively (23, 33). Concerning septic surgical principles, this is a remarkable finding. Immobilisation of the joint is a key principle for elemination of infections. As demonstrated, 8 months of temporary EA using an external fixation device was no obstacle rather than an important tool for the satisfying outcome at the 21 months follow-up.

Resection arthroplasty of the elbow should be mentioned as a further salvage procedure. Mostly fair and poor results with a high complication rate, leave resection arthroplasty a salvage option in patients with refractory infection and failed other surgical treatment options (3). Therefore, it was not regarded as a therapy option in our patient.

CONCLUSIONS

Despite the obstacles including destructive arthritis with *Staphylococcus aureus* of the right elbow and relevant comorbidities, such as diabetes mellitus type II, TEA was feasible by respecting septic surgery and antibiotic treatment principles. These key principles are eradication of the infection before implementation of the prosthesis and the use of antibiofilm antibiotics.

References

1. Achermann Y, Vogt M, Spormann C, Kolling C, Remschmidt C, Wust J, Simmen B, Trampuz A. Characteristics and outcome of 27 elbow periprosthetic joint infections: results from a 14-year cohort study of 358 elbow prostheses. Clin Microbiol Infect. 2011;17:432–438.
2. Alizadehkhaiyat O, Al Mandhari A, Sinopidis C, Wood A, frostick S. Total elbow arthroplasty: a prospective clinical outcome study of Discovery Elbow System with a 4-year mean follow-up. J Shoulder Elbow Surg. 2015;24:52–59.
3. Baghdadi YM, Veillette CJ, Malone AA, Morrey BF, Sanchez-Sotelo J. Total elbow arthroplasty in obese patients. J Bone Joint Surg Am. 2014;96:e70.
4. Broberg MA, Morrey BF. Results of treatment of fracture-dislocations of the elbow. Clin Orthop Relat Res. 1987:109–119.
5. Burkhart KJ, Dargel J, Wegmann K, Müller LP. [Conversion of elbow arthrodesis to total elbow arthroplasty]. Unfallchirurg. 2013;116:371–375.
6. Gächter A. Der Gelenkinfekt. Inform Arzt. 1985;6:35–43.
7. Gay DM, Lyman S, Do H, Hotchkiss RN, Marx RG, Daluiski A. Indications and reoperation rates for total elbow arthroplasty: an analysis of trends in New York State. J Bone Joint Surg Am. 2012;94:110–117.
8. Goldenberg DL. Septic arthritis. Lancet. 1998;351:197–202.
9. Gschwend N, Simmen BR, Matejovsky Z. Late complications in elbow arthroplasty. J Shoulder Elbow Surg. 1996;5:86–96.
10. 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;29:602–608.
11. Jenkins PJ, Watts AC, Norwood T, Duckworth AD, Rymaszewski LA, McEachan JE. Total elbow replacement: outcome of 1,146 arthroplasties from the Scottish Arthroplasty Project. Acta Orthop. 2013;84:119–123.
12. Kurtz SM, Lau E, Watson H, et al. Economic burden of periprosthetic joint infection in the United States. J Arthroplasty. 2012;27:61–65 e1.
13. Lohmander LS, Engesaeter LB, Herberts P, Ingvarsson T, Lucht U, Puolakka TJ. Standardized incidence rates of total hip replacement for primary hip osteoarthritis in the 5 Nordic countries: similarities and differences. Acta Orthop. 2006;77:733–740.
14. Mathews CJ, Weston VC, Jones A, Field M, Coakley G. Bacterial septic arthritis in adults. Lancet. 2010;375:846–855.
15. Morrey B, An K, Chao E. Functional evaluation of the elbow In: Morley BF (ed.). The elbow and its disorders. WB Saunders, Philadelphia, 1993, pp 86–97.
16. Mukka S, Berg G, Hassany HR, Koye AK, Sjödén G, Sayed-Noor AS. Semiconstrained total elbow arthroplasty for rheumatoid arthritis patients: clinical and radiological results of 1-8 years follow-up. Arch Orthop Trauma Surg. 2015;135:595–600.
17. Newman JH. Review of septic arthritis throughout the antibiotic era. Ann Rheum Dis. 1976;35:198–205.
18. O'Neill OR, Morrey BF, Tanaka S, An KN. Compensatory motion in the upper extremity after elbow arthrodesis. Clin Orthop Relat Res. 1992:89–96.
19. Otto RJ, Mulieri PJ, Cottrell BJ, Mighell MA. .Arthrodesis for failed total elbow arthroplasty with deep infection. J Shoulder Elbow Surg. 2014;23:302–307.
20. Palmqvist N, Foster T, Tarkowski A, Josefsson E. Protein A is a virulence factor in Staphylococcus aureus arthritis and septic death. Microb Pathog. 2002;33:239–249.
21. Pope D, Scaife SL, Tzeng TH, Vasdev S, Saleh KJ. Impact of diabetes on early postoperative outcomes after total elbow arthroplasty. J Shoulder Elbow Surg. 2015;24:348–352.
22. Renner L, Perka C, Trampuz A, Renz N. [Treatment of periprosthetic infections]. Chirurg. 2016;87:831–838.
23. Rog D, Zuckerman LM, Riedel B. Conversion of a surgical elbow arthrodesis to total elbow arthroplasty. Case Rep Orthop. 2015;2015:578189.
24. Rohner E, Kolar P, Seeger JB, Arnholdt J, Thiele K, Perka C, Matziolis G. Toxicity of antiseptics against chondrocytes: what is best for the cartilage in septic joint surgery? Int Orthop. 2011;35:1719–1723.

25. Singh JA, Ramachandran R. Sex differences in characteristics, utilization, and outcomes of patient undergoing total elbow arthroplasty: a study of the US nationwide inpatient sample. Clin Rheumatol. 2016;35:723–731.
26. Stutz G, Gachter A. Diagnosis and stage-related therapy of joint infections. Unfallchirurg. 2001;104:682–686.
27. Toulemonde J, Ancelin D, Azoulay V, Bonnevialle, N., Rongières, M., Mansat, P. Complications and revisions after semi-constrained total elbow arthroplasty: a mono-centre analysis of one hundred cases. Int Orthop. 2016;40:73–80.
28. Triplet JJ, Kurowicki J, Momoh E, Law TY, Niedzielak T, Levy JC. Trends in total elbow arthroplasty in the Medicare population: a nationwide study of records from 2005 to 2012. J Shoulder Elbow Surg. 2016;25:1848–1853.
29. Walter G, Kemmerer M, Kappler C, Hoffmann R. Treatment algorithms for chronic osteomyelitis. Dtsch Arztebl Int. 2012;109:257–264.
30. Williams H, Madhusudhan T, Sinha A. Mid-term outcome of total elbow replacement for rheumatoid arthritis. J Orthop Surg (Hong Kong). 2016;24:262–264.
31. Yamaguchi K, Adams RA, Morrey BF. Semiconstrained total elbow arthroplasty in the context of treated previous infection. J Shoulder Elbow Surg. 1999;8:461–465.
32. Zarkadas PC, Cass B, Throckmorton T, Sanchez-Sotelo J, Morrey B. Long-term outcome of resection arthroplasty for the failed total elbow arthroplasty. J Bone Joint Surg Am. 2010;92:2576–2582.
33. Zhou H, Orvets ND, Merlin G, Shaw J, Dines JS, Price MD, Eichinger JK, Li X. Total elbow arthroplasty in the United States: evaluation of cost, patient demographics, and complication rates. Orthop Rev (Pavia). 2016;8:6113.

Corresponding author:
Markus Rupp MD
Department of Trauma,
Hand and Reconstructive Surgery
University Hospital Giessen - Marburg, GmbH
Campus Giessen
Rudolf-Buchheim-Strasse 7
35385 Giessen, Germany
E-mail: markus.rupp@chiru.med.uni-giessen.de