



Type III open complete articular fractures of the distal humerus: case series outcomes after orthoplastic reconstruction



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ARTICLE INFO

Keywords:

Open
Distal
Humerus
Functional
Outcomes
Orthoplastic

Level of evidence: Level IV; Retrospective Case Series

Background: Open complete articular injuries of this distal humerus are rare injuries which are challenging to manage. The study unit aims to present a small case series of Gustilo-Anderson type III open complete articular fractures which have undergone a single-stage definitive fixation and soft-tissue coverage, presenting their functional outcomes.

Methods: Retrospective case series identifying all type IIIB AO 13-C3 distal humeral fractures from the unit trauma database. The primary outcome was the Oxford Elbow Score. Secondary outcomes included deep infection, nonunion, and reoperation.

Results: A total of six patients were identified, (four open type IIIA, 2 type IIIB). All patients underwent single-sitting definitive fixation and soft-tissue coverage. Mean range of motion arc was 90 degrees. The median Oxford Elbow Score was 35 (range 21–43), representative of mild to moderate arthritis. One patient (n = 1) developed deep infection at 24 months and required reoperation. All patients (n = 6) proceeded to union at the latest follow-up. We present a case report of a 59-years-old patient who sustained a type IIIB, AO 13-C3 distal humeral fracture who underwent single-sitting definitive fixation and flap coverage.

Conclusion: This case series reports that positive functional outcomes representative of mild/moderate arthritis at short to midterm follow-up can be achieved after definitive fixation and soft-tissue coverage in a single sitting, including when the soft tissue is deficient. This is a rare injury which is under-reported in the literature.

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Complete articular distal humeral fractures (AO 13-C3) are uncommon injuries, accounting for around 1% in the older than 50-year-old population, with open injuries of this nature being even rarer.¹ These are challenging injuries to manage, with this being particularly the case in the elderly population, where the injury is compounded by osteoporotic bone and increased metaphyseal comminution, creating significant difficulty in achieving anatomic reduction and stabilization.¹⁹

Operative management broadly consists of either open reduction and internal fixation (ORIF) or elbow arthroplasty. Arthroplasty is technically challenging as a primary treatment

option for complete articular fractures and has largely been reserved as a salvage option for failed primary fixation, nonunion, post-traumatic arthritis, instability or those not amenable to stable fixation.^{12–14} Furthermore, the literature suggests complication rates are higher when this is option is used as a primary procedure,¹¹ and there is justifiable hesitancy to use this in the open-fracture situation.

More recently, ORIF has become the treatment of choice, with the literature suggesting that poor bone quality is not a contraindication for this procedure, which stabilizes the elbow and allows early rehabilitation.^{8,10,17} However, reports on the functional outcomes of primary ORIF in AO 13-C3 injuries are scarce for open injuries. This is particularly the case for injuries which undergo definitive internal fixation and soft tissue coverage in a single operative sitting.

The aim of this study was to report functional outcomes in Gustilo-Anderson type III open AO 13-C3 injuries of the distal humerus in an adult population.

Ethical approval was obtained for this study.

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<https://doi.org/10.1016/j.xrrt.2021.03.006>

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Table 1
Case series by patient.

Patient number	Sex	Age	AO	GA type	Olecranon osteotomy	ROM	Wound location/size	Follow-up (mo)	Complications	OES
1	M	59	13-C3	3B	No	30 to 110 degrees	As per Fig. 1a/1b	44	Nil	34
2	M	35	13-C3	3B	Yes	30 to 110 degrees	Posterolateral elbow measuring 4x5 cm	22	Nil	36
3	M	47	13-C3	3A	No	25-105 degrees,	Direct posterior to olecranon measuring 5x5 cm	25	Wound infection	41
4	M	74	13-C3	3A	Yes	10-140 degrees	Posteromedial elbow measuring 4x4 cm	15	Nil	43
5	M	60	13-C3	3A	No	45-135 degrees	Posterior elbow – puncture wound	31	Nil	27
6	M	58	13-C3	3A	Yes	20-130 degrees	Posterior elbow – puncture wounds	6 (and continued)	Nil	21

GA, Gustilo-Anderson; OES, Oxford Elbow Score; ROM, range of motion.

Methods

Eligibility

This was a retrospective case-series conducted in a level 1 UK major trauma center. The unit trauma database was used to identify all adult patients who presented to our unit between 2011 and 2019, with an open Gustilo-Anderson type III, complete articular fracture (AO 13-C3) of the distal humerus. This fracture group was chosen as this represents the most complex fracture group owing to the bony and soft-tissue challenges required.

Outcomes

The primary outcome was the Oxford Elbow Score (OES).⁹ The OES is a validated functional outcome and consists of a subjective 12-point questionnaire, on a graded Likert scale of satisfaction. This aims to elicit daily function (activities of daily living, hobbies, work, and leisure), pain and effect on sleep. The maximum score is 48. A maximum score of 40-48 indicates satisfactory elbow function, 30-39 mild to moderate elbow arthritis, 20-29 severe elbow arthritis, and 0-19 severe elbow arthritis which is highly likely to require intervention. The OES has been shown to be superior to that of the Disability of the Arm, Shoulder and Hand score.⁷

The secondary outcomes were deep infection rate, nonunion, and reoperation.

Surgical technique

All patients were managed in a level 1 ortho-plastic center, where patients underwent emergent open-fracture management as per national guidelines.⁴ Patients undergo initial debridement within 24 hours on a dedicated ortho-plastic trauma list with consultant surgeons experienced in the management of open injuries. The soft-tissue open wound is extended along the incision line and the entire zone of injury exposed before a meticulous debridement occurs. This involves inspection of skin, with excision of any skin that shows underlying venous thrombosis or dermo-fascial degloving. After identification and protection of relevant neurovascular structures, devitalized muscle is debrided. Skeletal stabilization is undertaken as per complexity of injury and bone quality. However, this invariably involves dual plating, either parallel or orthogonal. A decision is then made on whether the soft-tissue injury is amenable to primary closure. If the skin closed without significant tension, then primary closure occurs. Failing this soft-tissue coverage is undertaken in the same surgical sitting using a free vascularized dermo-fascial flap.

Patients are kept under monitoring of the flap for a minimum of 5 days, before early range of motion is permitted. Patients are followed up until union and optimization of functional recovery.

Data collection

Local ethical approval was obtained for this study. All data, such as patient demographics, comorbidities (smoking and diabetes), follow-up, complications, and radiographic measurements, were stored on a secure database to protect patient confidentiality.

Patients eligible for the study were contacted via post to obtain consent for participation in this study, followed by a questionnaire of the OES, which was returned by the patient.

Results

A total of six patients (n = 6) are presented in this study, two of whom sustained Gustilo-Anderson Type IIIB injuries requiring soft-tissue coverage. This was undertaken using the two-stage approach described previously. The second stage consisted of a single-sitting definitive fixation and flap coverage. For the remaining four patients (n = 4) who had Gustilo Type IIIA injuries, these were undertaken in a single-sitting debridement, definitive fixation and soft-tissue closure (no flap).

The median OES was 35 (range 21-43). One patient (n = 1) developed deep infection at 24 months and required reoperation. All patients (n = 6) proceeded to union at the latest follow-up. [Table 1](#) presents details of patient injury, management, and follow-up.

Case report

We present a case of a 59-year-old man (patient 1) who was involved in a car vs. truck road traffic accident, sustaining an open type IIIB complete articular injury to his distal humerus ([Fig. 1, A and B](#)). He was resuscitated in the emergency department until fit for transfer for pan-computed tomography as part of the primary survey before transfer to theatre for debridement. This was a nonischemic injury. Initial management consisted of orthoplastic debridement of the wound within 4 hours of injury followed by temporary stabilization of the limb using internal fixation ([Fig. 2](#)). Stage two was undertaken within 72 hours of admission, with a single-sitting re-debridement, definitive internal fixation, and anterolateral thigh flap for soft-tissue coverage using a free flap ([Fig. 3, A and B](#)).

At the final follow-up, he continued to progress with no signs of deep infection and full union at 1 year ([Fig. 4, A and B](#)). He demonstrated excellent function with a functional range of motion ([Fig. 5, A and B](#)) and an OES of 34.

One patient (patient 3, [Table 1](#)) experienced deep infection 12 months after initial surgery. This patient presented with a medial sinus which was draining. This was electively excised, with removal of metalwork and a total of 12 weeks intravenous followed by oral antibiotics. This patient healed uneventfully thereafter.

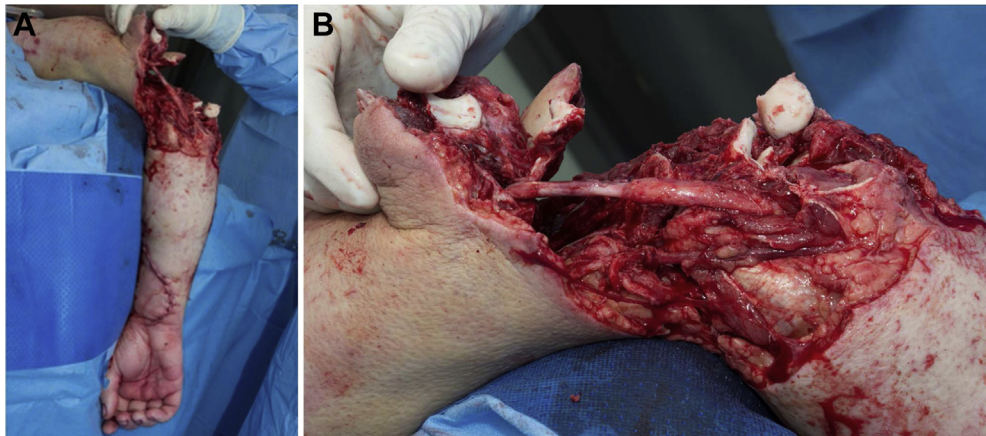


Figure 1 (A) Soft tissue injury to right elbow. (B) Extensive soft tissue and bone loss after initial debridement.

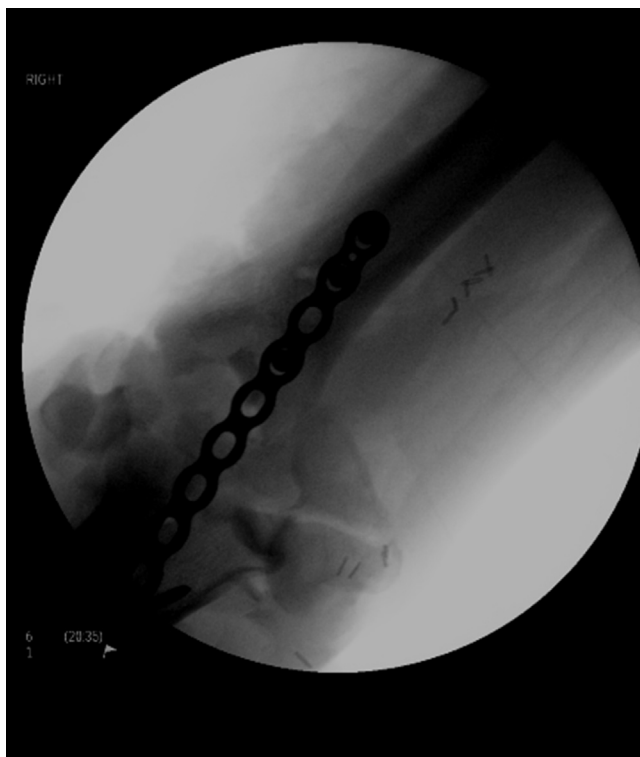


Figure 2 Temporary stabilization after intimal debridement of the wound before stage two.

Discussion

This study reports the functional and clinical outcome of adult patients with devastating open type III complete articular fracture of the distal humerus. All patients underwent ORIF, with single-sitting orthoplastic soft-tissue coverage. Patients were associated with an OES that discerned mild to moderate arthritis. Furthermore, 1 patient developed deep infection requiring reoperation. All patients proceeded to union.

Open distal humeral fractures mainly affect the adult population, often as a result of high-energy injuries. There is a significant paucity of evidence on this specific injury type in the literature. It is thought that complete articular fractures of the



Figure 3 (A) Immediate postoperative anteroposterior radiograph of the right elbow. (B) Immediate postoperative lateral radiograph of the right elbow.

distal humerus account for around 2% of the adult population.^{6,16} To the authors' best knowledge, there is little information published on function after this rare but devastating injury. Korner et al¹⁰ reported on 63 patients with distal humeral fractures, 29 of which were AO 13-C3 injuries, 9 of whom experienced a poor functional outcome after ORIF. Four type 3A open injuries were

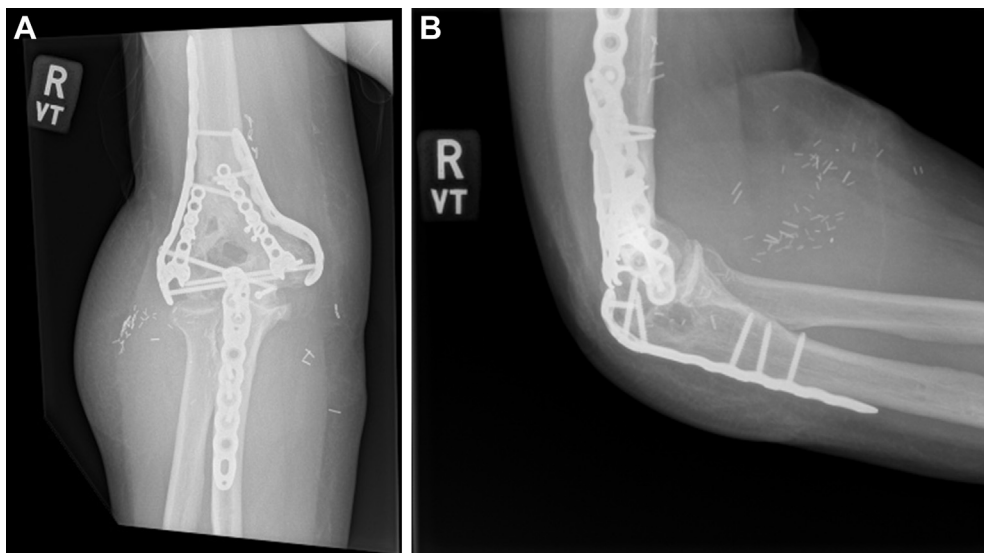


Figure 4 (A) Anteroposterior radiograph of right elbow at 1 year. (B) Lateral radiograph of right elbow at 1 year.

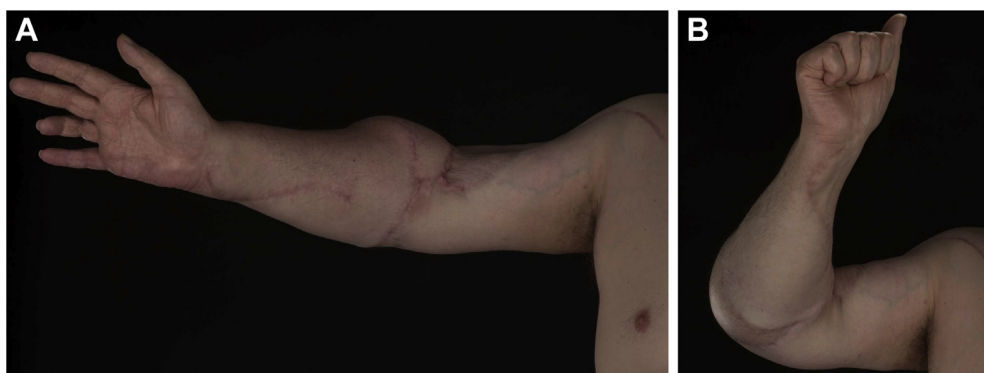


Figure 5 (A) Soft tissue and functional outcome in extension. (B) Soft tissue and functional outcome in flexion.

seen in this cohort; however, there was no mention of severity of bony injury or specific outcomes for these. Tornetta et al analyzed 18 patients with an open distal humeral fracture requiring multiple débridements and external fixation. At a mean follow-up of 34 months, 70% of patients achieved a functional outcome of good or excellent.¹⁵ Chaudhary et al⁵ also looked at 8 patients who sustained type III open injuries of the distal humerus, managed using a mini external fixation construct. All wounds were amenable to tension free primary closure. Using the Cassebaum functional rating system, only two patients achieved an excellent functional outcome at the two-year follow-up.

To the authors' knowledge, this study is alone in reporting the functional and clinical outcomes of this complex injury, using single-sitting definitive fixation and soft-tissue coverage. The outcome score used is specifically designed to look for function of daily living as well as those correlating with arthritic symptoms. The study unit is experienced in the management of significant high-energy open injuries requiring ortho-plastic care.^{2,3,18} Furthermore, in this small case series, single-sitting management of this injury seems to be associated with positive functional outcomes. Although clearly this should be interpreted with caution given the small series, it suggests that primary closure where possible is a reasonable strategy.

There are limitations to this study. It is a small case series, although this is representative of the rarity of this injury both in clinical practice and in the literature. No associations or causation can be inferred from this retrospective series, and therefore, it needs to be interpreted with caution. This study is simply designed as an introduction to this rare but complex injury pattern and to raise awareness about the potential for primary closure where experience permits with the expectation of a satisfactory functional outcome.

Conclusion

Open complete articular fractures of the distal humerus are complex bony and soft-tissue injuries. This case series reports that positive functional outcomes representative of mild/moderate arthritis at short to midterm follow-up can be achieved after single-sitting definitive fixation and primary closure/flap coverage. This is a rare injury which is under-reported in the literature.

Disclaimers

Funding: No funding was disclosed by the author(s).
 Conflicts of interest: The authors, their immediate families, and any research foundations with which they are affiliated have not

received any financial payments or other benefits from any commercial entity related to the subject of this article.

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