

## Background -Objectives

The interpretation of distal clavicle fractures is challenging because of the inherent difficulty to distinguish between various fracture patterns, particularly unstable types that are indicative for internal fixation. Unstable 'extra-lateral' fractures (lateral to the coracoclavicular ligaments) with superior dislocation of medial clavicle are not included in the modified Neer classification and due to their small size, they cannot always afford traditional hardware. In the existing literature, there is no optimal surgical technique for managing such fractures and are commonly included with Neer IIb fractures. The aim of this study is to perform a systematic search of the literature to identify all studies evaluating the effectiveness and safety of coracoclavicular fixation techniques for managing unstable Neer IIb and extra-lateral (IIc) fractures of the distal clavicle in skeletally mature patients, and to present the clinical and radiological outcomes of three patients with extra-lateral fractures managed with closed loop double button open coracoclavicular fixation at our institution

## Study Design & Methods

We performed a systematic review of the literature to capture all studies evaluating the safety and effectiveness of existing coracoclavicular loop techniques for unstable Neer IIb and extra-lateral (IIc) fractures of the distal clavicle. We searched the PubMed (Medline and PubMed Central), Scopus, Web of Science, Google Scholar, and Cochrane Central Register of controlled Trials electronic databases to retrieve studies published between January 2000 and November 2020 (Table 1). We also present the clinical and radiological outcomes of three patients with IIc fractures managed with closed loop double button coracoclavicular fixation via an open approach at our institution. Both the systematic review and case series were guided by a prospectively developed protocol and the latest guidelines.

## Results

Our database search yielded a total of 564 records, out of which 21 were deemed appropriate for inclusion in our qualitative synthesis. The total number of reported IIb/c fractures managed with a coracoclavicular stabilisation technique in all studies was 421. In total, 139 (33%) patients received arthroscopic assisted treatment and 282 (67%) patients open techniques of coracoclavicular stabilization. The reported clinical results were very good to excellent in most studies, whereas the overall major and minor complication rate was 2.6% and 12.8%, respectively. Major complications were more frequent in arthroscopic assisted techniques (4.3%) compared to open (1.8%).

Table 1. Search methodology and chart flow of excluded studies

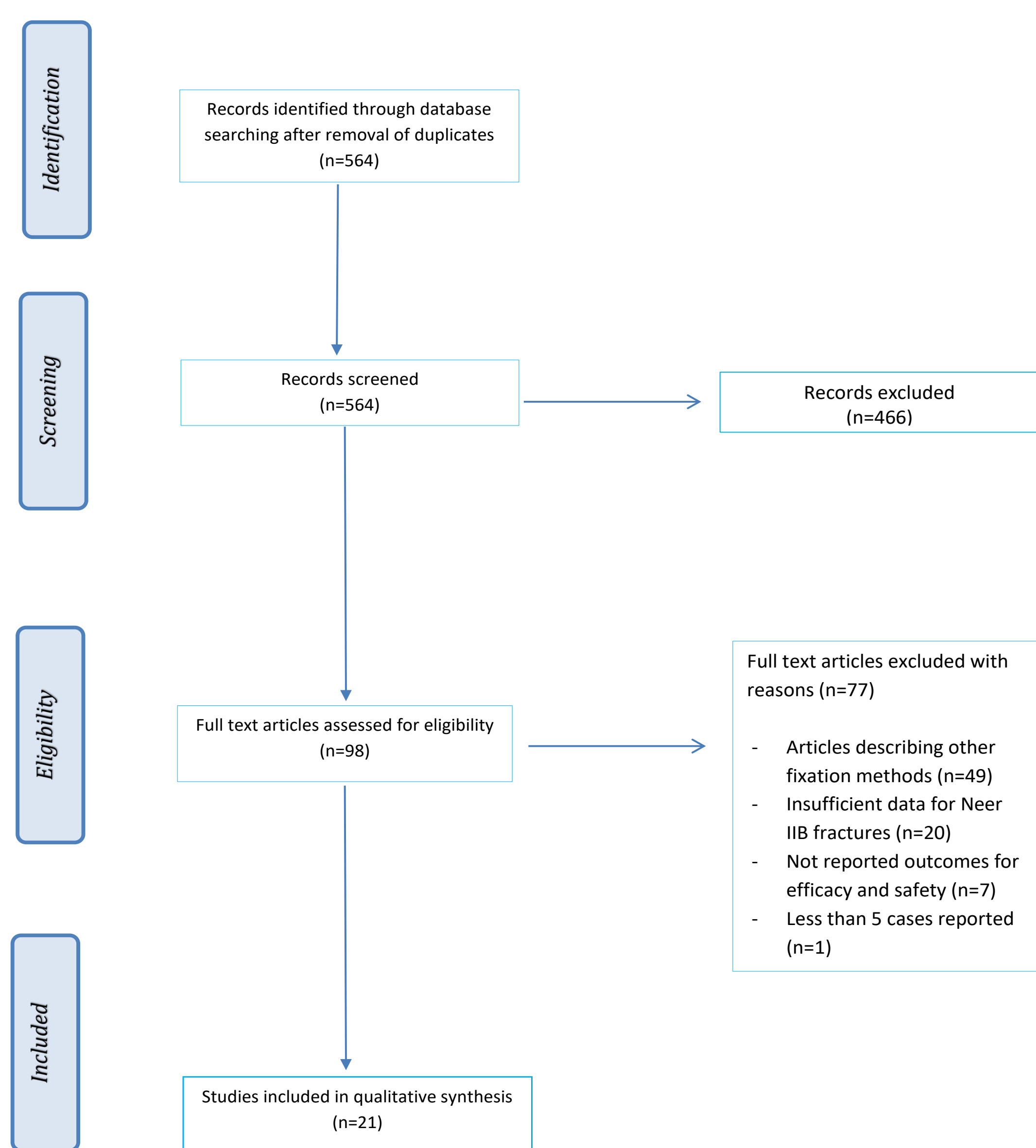


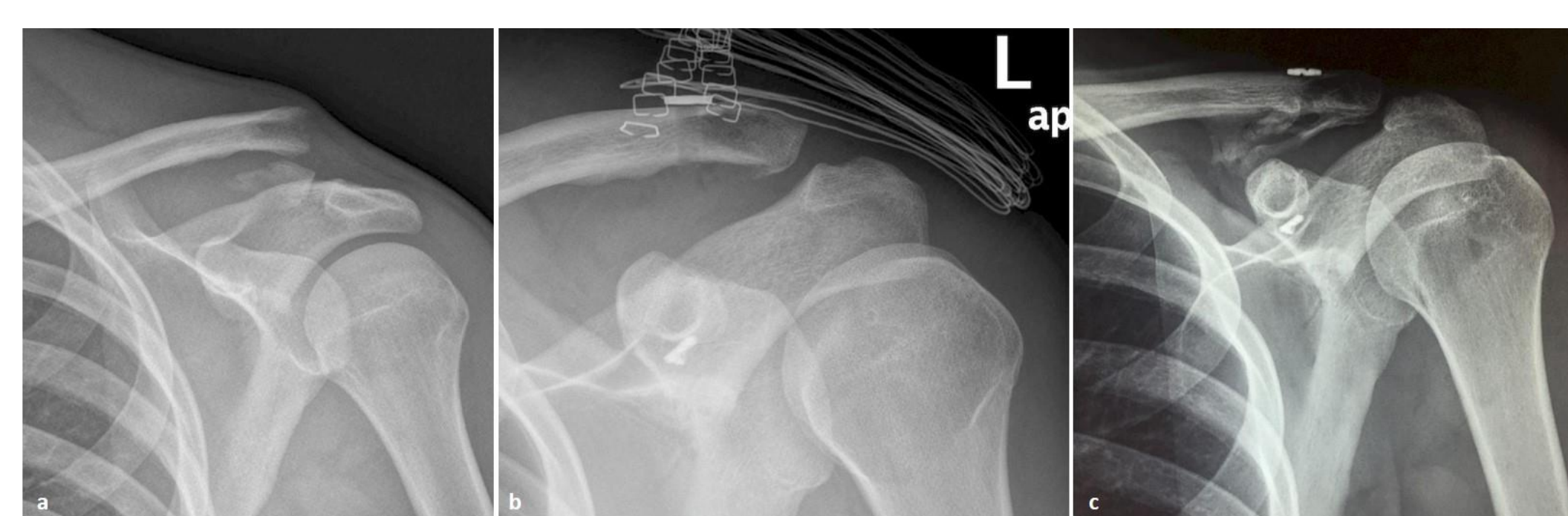
Table 1: Summary of key characteristics of included studies that report data on Neer IIb/Cho IIc fractures

Author (Country)	Year	Study design	Neer IIb/Cho IIc	Mean age (years)	Male/female	Surgical technique	Follow up (months)
Chen et al. (Taiwan)	2002	Retrospective	11	37	8/3	CC stabilization with Mersilene tape and interfragmentary wire	27
Shin et al. (Korea)	2009	Retrospective	19	43.4	14/5	Two suture anchors fixation augmented with fragment suture tension band	4.6
Li et al. (China)	2011	Retrospective	29	34	21/8	Open CC stabilization with 2 titanium cables (drill hole in the coracoid)	32
Yang et al. (Taiwan)	2011	Retrospective	28	37.9	18/10	Open CC stabilization (mersilene tape)	57.3
Takase et al. (Japan)	2012	Retrospective	7	41.9	7/0	Arthroscopic CC stabilization with Endobutton and artificial ligament (+ washer in clavicle)	29
Motta et al. (Italy)	2014	Retrospective	10	32	10/0	Arthroscopic CC stabilization with TightRope	24
Chen et al. (Taiwan)	2014	Retrospective comparative	40	43.2	28/12	CC stabilization with Mersilene tape	38.2
Loriaut et al. (France)	2015	Retrospective	21	33	14/7	Arthroscopic CC stabilization with TightRope	35
Kanchanatawan et al. (Thailand)	2015	Retrospective	39	37.5	32/7	Modified CC stabilization with subcoracoid fiberwire sutures tight over 2 endobuttons	35.7
Choi et al. (Korea)	2015	Retrospective	13	40.1	8/5	Open CC stabilization with double button (4) or suture anchor (9) and KW-tension band fragment fixation	14.1
Struhl & Wolfson (USA)	2016	Retrospective	6	43	4/2	Open CC stabilization with closed-looped double endobutton + suture fixation	40
Cano-Martínez et al. (Spain)	2016	Retrospective	12	32.2	10/2	Open CC stabilization with Twin Tail TightRope	26
Cho et al. (Korea)	2017	Retrospective	18	48.6	8/10	Open CC stabilization with TightRope	46
Cisneros et al. (Spain)	2017	Retrospective	9	36	5/4	Arthroscopic CC stabilization with TightRope (+ fragment sutures)	49
Blake et al. (USA)	2017	Retrospective	17	41	12/5	Arthroscopic CC stabilization with TightRope + fiberwire AC joint tension band	12
Sautet et al. (France)	2018	Retrospective	14	34.6	10/4	Arthroscopic CC stabilization with subcoracoid suture and button (Dog Bone)	20
Xiong et al. (China)	2018	Retrospective comparative	16	NR	NR	Arthroscopic double Endobutton fixation	57
Mochizuki et al. (Japan)	2019	Retrospective	45	34.3	NR	Arthroscopic CC stabilization with Zip Tight (+ AC joint KW)	18.6

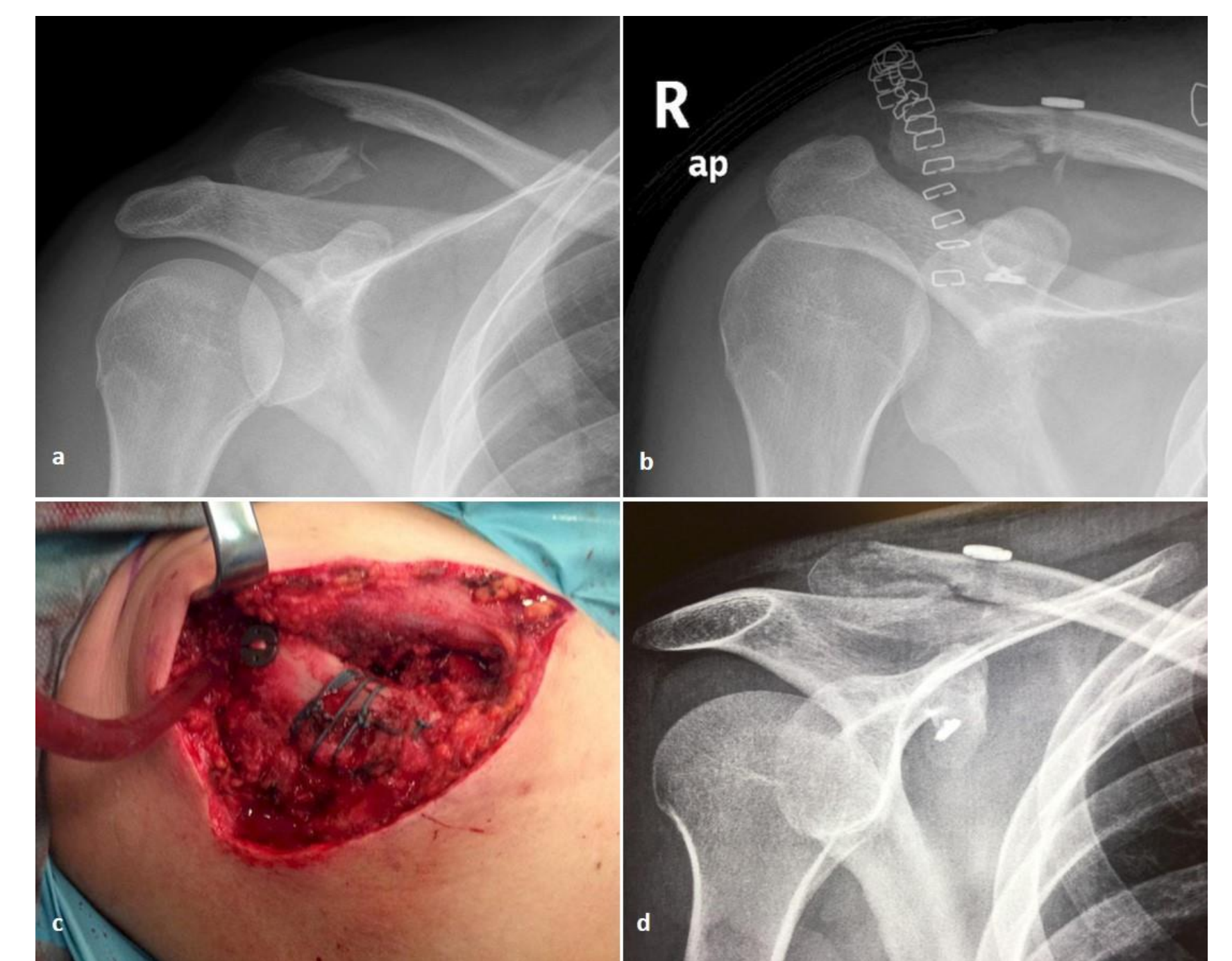
All three patients presented in our case series had maintained reduction and showed excellent Constant and Acromioclavicular Joint Instability Score at their latest follow up.



**Figure 1:** (a) preoperative radiograph showing an extra-lateral fracture of the distal clavicle, (b) excellent postoperative reduction using a closed loop double button system, (c,d) last follow up radiographs showing maintenance of reduction and no signs of osteolysis or loosening.



**Figure 2:** (a) preoperative radiograph of an extra-lateral distal clavicle fracture, with comminution and marked vertical displacement, (b,c) postoperative radiograph and intraoperative photo showing reduction of the fracture and additional interfragmentary suture repair in respect, (d) final follow up radiograph showing maintenance of reduction.



**Figure 3:** (a) Preoperative radiograph of an extra-lateral distal clavicle fracture with marked medial fragment displacement, (b) postoperative radiograph showing excellent reduction of the fragment, (c) final follow up radiograph showing maintenance of reduction and calcification of CC ligaments, a sign of adequate healing.

## Conclusions

The present systematic review and case series demonstrate promising clinical outcomes, including effectiveness and safety. We support the previously proposed modification of the Neer classification to include this unique type of unstable extra-lateral fracture (type IIc) to allow for targeted surgical management.

## References

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