

## Outcomes of Operatively Treated Non-unions and Symptomatic Mal-unions of Adolescent Diaphyseal Clavicle Fractures

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**Objectives:** The purpose of the study was to review the clinical characteristics and outcomes of adolescent diaphyseal clavicle fractures treated surgically for non-union, impending non-union, or symptomatic mal-union, which are rare complications of primary non-operative treatment.

**Methods:** Records of all patients 10-18 years-old who underwent surgery at a tertiary-care children's hospital between 2003-2013 for a symptomatic mal-union, non-union (no bony bridging >6 mo post-fx), or impending non-union (no callus 1-6 mo post-fx) of a clavicle shaft fracture were reviewed. Demographic data, radiographic features, operative details, and post-operative course were analyzed and compared to an age-matched, sex-matched, and fracture pattern-matched control group of adolescents who underwent plate fixation as primary fracture treatment.

**Results:** Sixteen patients (56% male; mean age 15.4 years, range 12.4-17.7 years) met inclusion/exclusion criteria, most of whom (87.5%) were initially treated at an outside hospital. Plate fixation, with or without osteotomy, was performed in 14 cases (87.5%), with bone grafting in 13 cases (81.3%), including iliac crest autograft (n=4), local bone graft (n=4), cancellous allograft (n=1), or local graft + cancellous allograft (n=4). Two mal-union cases (12.5%) underwent ostectomy only. Comparisons of mean time between injury and surgery, time to healing, duration between surgery and return to sports, and rate of removal of hardware (excluding the two ostectomy patients) are detailed in Table 1.

**Conclusion:** Adolescents who underwent surgery for diaphyseal clavicle fracture non-union, impending non-union or symptomatic mal-union demonstrated bony healing and returned to sports within 2-4 months, with a comparable post-operative course and rate of subsequent hardware removal to patients treated with plate fixation for their primary clavicle fracture. To address the rare instance of slow, failed, or painful healing following non-operative management of diaphyseal clavicle fracture in adolescents, surgical treatment, which may be more technically challenging and often requires bone grafting, has clinical and radiographic results that are comparable to primary fracture fixation.

Table 1

(Mean values, in months)	All (1+2+3) (n=16)	1.Non-union (n=6)	2. Impending (n=6)	3. Malunion (n=4)	CONTROL (n=15)	p-value
Injury to Surgery	9.3	9.4	2.2	19.8	0.4	<0.001
Time to union	2.8	4.1	2.7	2.9	2.9	0.99
Surgery to Sports	3.6	4.3	3.6	2.6	--	--
Rate of ROH	21% (3/14)	0% (0/5)	50% (3/6)	0% (0/2)	20% (3/15)	1.00

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