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Role of autologous non-vascularised intramedullary fibular strut graft in humeral shaft nonunions following failed plating

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ABSTRACT

Background: Non-union humeral shaft fractures are seen frequently in clinical practice at about 2–10% in conservative management and 30% in surgically operated patients. Osteosynthesis using dynamic compression plate (DCP), intramedullary nailing, locking compression plate (LCP), Ilizarov technique along with bone grafting have been reported previously. In cases of prior failed plate-screw osteosynthesis the resultant osteopenia, cortical defect, bone loss, scalloping around screws and metallosis, make the management of non-union more complicated. Fibular graft as an intramedullary strut is useful in these conditions by increasing screw purchase, union and mechanical stability. This study is a retrospective and prospective follow up of revision plating along with autologous non-vascularised intramedullary fibular strut graft (ANVFG) for humeral non-unions following failed plate osteosynthesis.

Materials and methods: Seventy eight cases of nonunion humeral shaft fractures were managed in our institute between 2008 and 2015. Of these, 57 cases were failed plate osteosynthesis, in which 15 cases were infected and 42 cases were noninfected. Out of the 78 cases, bone grafting was done in 55 cases. Fibular strut graft was used in 22 patients, of which 4 cases were of primary nonunion with osteoporotic bone. Applying the exclusion criteria of infection and inclusion criteria of failed plate osteosynthesis managed with revision plating using either LCP or DCP and ANVFG, 17 cases were studied. The mean age of the patients was 40.11 yrs (range: 26–57 yrs). The mean duration of non-union was 4.43 yrs (range: 0.5–14 yrs). The mean follow-up period was 33.41 months (range: 12–94 months). The average length of fibula was 10.7 cm (range: 6–15 cm). Main outcome measurements included bony union by radiographic assessment and pre- and postoperative functional evaluation using the DASH (Disabilities of the Arm, Shoulder and Hand) score. Results: Sixteen out of 17 fractures united following revision plating and fibular strut grafting. Average time taken for union was 3.5 months (range: 3–5 months). Complications included one each of implant failure with bending, transient radial nerve palsy and transient ulnar nerve palsy. No case had infection, graft site morbidity or peroneal nerve palsy. Functional assessment by DASH score improved from 59.14 (range: 43.6–73.21) preoperatively to 23.39 (range: 8.03–34.2) postoperatively ($p = 0.0003$). Conclusion: The results of our study indicate that revision plating along with ANVFG is a reliable option in humeral diaphyseal non-unions with failed plate-screw osteosynthesis providing adequate screw purchase, mechanical stability and high chances of union with good functional outcome.

1. Introduction

Humeral shaft fractures are relatively common injuries accounting for 5–8% of all fractures in human body and 14% of all fractures of humerus.[1] Historically, fractures of humerus have been associated with high incidence of non-union. The advent of bracing and operative stabilization techniques led to significant decline in non-union rate.[2] Both conservative and surgical treatment result in healing. Conservatively managed humeral shaft fractures present with non-union rates of 2–10%, with most of the cases resulting from proximal third fractures or those with a proximal butterfly fragment.[3] In a review by Volgas et al., surgically managed fractures fared even worse with non-union rate as high as 30%.[4]

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Most of the non-union humeral shaft fractures can be managed successfully by conventional methods such as Dynamic Compression Plate (DCP) or Locking Compression Plate (LCP) fixation, intramedullary nailing, Ilizarov technique and bone grafting. These therapeutic options alone or in combination can achieve bony union in 82-95% of patients.[5] In multi-operated cases extensive bone loss due to previous implant, scalloping around screws, metallosis, osteopenia, nonviable intermediate butterfly fragments and instability pose a challenge for the surgical management along with risk factors such as alcoholism, diabetes mellitus, smoking, obesity and osteoporosis.[3,6] The use of fibular graft as an intramedullary strut in humeral nonunions was originally described by Wright et al. in a clinical and biomechanical study.[7]

The purpose of this study is to assess the role of autologous nonvascularized intramedullary fibular strut graft (ANVFG) in non-union diaphyseal humeral fractures following failed plate-screw osteosynthesis.

2. Materials and methods

2.1. Study design

A retrospective and prospective study was conducted after obtaining the Institutional Ethical Committee approval from our Institute. Seventy eight cases of nonunion humeral shaft fractures were managed at our institute between 2008 and 2015. Of these, 57 cases were failed plate osteosynthesis, in which 15 cases were infected nonunion managed with Ilizarov method and 42 cases were non-infected managed with revision plating either with or without bone graft. Out of the 78 cases, either iliac crest or fibular bone graft was used in 55 cases. Fibular strut graft was used in 22 patients, of which 4 cases were of primary nonunion with osteoporotic bone. Applying the *exclusion criteria* of infection, pathological fractures, primary non-union, and revision cases managed with or without iliac crest bone graft alone and *inclusion criteria* of failed plate osteosynthesis managed with revision plating and ANVFG, we were left with 17 cases for the study (Table 1).

2.2. Demographic data

There were 14 male and 3 female patients. The mean age was 40.11 yrs (range: 26–57 yrs). 9 patients had right side and 8 patients had left side involvement. Type of non-union was classified according to Weber and Cech classification.[8] Fourteen patients had atrophic type of non-union and 3 patients had comminuted type of avascular non-union. One patient had non-union at proximal third-middle third junction, 10 patients had

Table 1
Patient data.

S/NO	Age (yrs)	Sex	Side	Site	Duration of Nonunion (months)	No. of Prior Surgeries	Type of Nonunion	Risk factors	Approach
1	48	M	Rt	D/3rd	6	1	comminuted type	nil	posterior
2	33	M	Lt	M/3rd	8	1	atrophic type	nil	posterior
3	38	M	Rt	M/3rd	60	2	atrophic type	nil	posterior
4	48	M	Lt	M/3rd	48	1	atrophic type	Hepatitis B, Hepatitis C	posterior
5	28	M	Lt	M/3rd	12	1	atrophic type	epilepsy, on anti-epileptics	posterior
6	42	M	Rt	D/3rd	6	1	atrophic type	smoking- 10yrs	posterior
7	50	M	Lt	M/3rd	48	2	atrophic type	Hypertension	anterolateral
8	27	M	Lt	M/3rd	8	1	comminuted type	nil	anterolateral
9	57	F	Rt	M/3rd	144	1	atrophic type	Diabetes Mellitus, Hepatitis B	posterior
10	53	M	Lt	M/3rd	48	1	atrophic type	Diabetes Mellitus	anterolateral
11	30	M	Rt	M/3rd-D/3rd	48	1	atrophic type	nil	anterolateral
12	26	M	Lt	D/3rd	24	1	atrophic type	nil	posterior
13	45	F	Lt	M/3rd-D/3rd	72	1	comminuted type	nil	anterolateral
14	50	F	Rt	M/3rd	60	1	atrophic type	Hypertension	posterior
15	36	M	Rt	M/3rd	168	1	atrophic type	nil	anterolateral
16	36	M	Rt	D/3rd	24	2	atrophic type	Smoking-20yrs	anterolateral
17	35	M	Rt	P/3-M/3rd	120	1	atrophic type	Smoking	anterolateral

S/No	Age (yrs)	Sex	Implant	Fibula	Iliac Crest	Post Operative Complications	Union (months)	Duration of Followup (months)	Pre Op DASH Score	DASH Score at Final Followup
1	48	M	DCP	10 cm hemi	–	nil	3	94	73.21	8.03
2	33	M	DCP	8 cm	–	nil	3	69	44.4	12.5
3	38	M	DCP	12 cm	–	nil	4	59	43.6	21.9
4	48	M	DCP	14 cm	–	nil	4	46	46.29	32.4
5	28	M	DCP	8 cm	–	nil	3	36	58.3	12.96
6	42	M	DCP	6 cm	–	nil	3	36	47.32	15.17
7	50	M	DCP	8 cm	–	nil	3	31	61.11	28.7
8	27	M	DCP	10 cm hemi	–	implant failure – bending of plate	nil	30	48.1	29.6
9	57	F	DCP	13 cm	–	nil	4	25	66.4	34.2
10	53	M	DCP	14 cm	+	nil	4	23	59.2	31.48
11	30	M	DCP	15 cm	+	iatrogenic fracture during implant removal	4	22	61.6	14.28
12	26	M	LCP	15 cm	+	ulnar nerve palsy recovered in due course of time	5	21	58.3	19.6
13	45	F	DCP	8 cm	–	wrist drop recovered by 3 months	3	18	69.25	33.3
14	50	F	DCP	10 cm hemi	–	nil	3	17	60.7	24.1
15	36	M	LCP	15 cm	–	nil	4	15	66.6	30.5
16	36	M	DCP	7 cm	+	Nil	3	14	68.75	21.4
17	35	M	PHILOS	10 cm	–	Nil	3	12	72.31	27.67

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