Addressing humeral nonunion after failed fixation: A systematic review comparing techniques

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INTRODUCTION: Humeral shaft fractures are known to have a relatively low incidence, accounting for approximately 3% of all fractures, with an estimated annual incidence of 14.5 per 100,000 fractures. The primary treatment options for these fractures include nonoperative management and open reduction and internal fixation (ORIF). However, depending on the specific requirements of the individual patient, alternative operative techniques such as intramedullary nailing, Ilizarov external fixation, monolateral external fixation, cortical allograft struts, and vascular autografts have also been employed. Although nonunions of humeral shaft fractures have been extensively studied, the current literature predominantly focuses on nonunions following nonoperative management, while inadequate attention has been given to the unique concerns associated with nonunion following surgical intervention. Therefore, the purpose of this study was to perform a systematic review and investigate union rates, complications, and time to union of the current surgical techniques for postoperative humeral shaft nonunion repair.

METHODS: A Systematic review of the English-language literature in Medline, Scopus, Cochrane Library, and Google Scholar, including all level 1-4 studies from 1990-2001. Included studies reported on union rates, time-to-union, at least 5 patients, and complications of nonunions that were previously treated surgically. Furthermore, aseptic, infectious or nonunions secondary to pathologic fracture were independently reported. The outcomes were compiled into groups of open reduction internal fixation (ORIF), intramedullary nailing (IMN), monolateral external fixation (MEF), Ilizarov fixation (IF), cortical allograft struts (CAS), and vascularized autograft (VA). Heterogeneity was assessed using χ^2 and I^2 statistics.

RESULTS:

Union Rates

The total union rate after repair of postoperative nonunions was 96.5% (412 out of 427) with a reported average time to union of approximately 5.5 months. ORIF had the highest percentage of union rates at 98.6%, along with the most surgeries performed (213 of 427). Fifteen of 427 indexed procedures resulted in secondary failure. The failure rates for all of the modalities from highest to lowest were: IMN at 0.222 (p=0.473), MEF at 0.079 (p= 0.027), CAS at 0.050 (p= 0.0001), IF at 0.047 (p= 0.0001), VA at 0.036 (p= 0.0001), and ORIF at 0.030 (p= 0.0001).

Time to Union

The time to union for all modalities from fastest to slowest was CAS at 3.2 months (p= 0.0001), VA at 3.8 months (p = 0.0001), IMN at 4.3 months (p= 0.0001), MEF at 4.5 months (p= 0.0001), ORIF at 4.6 months (p= 0.0001), and IF at 5.3 months (p= 0.0001).

Complications

A total of 102 complications were found (56 major, 46 minor). The aggregate complication event rate for all of the modalities from the highest to lowest were: IF at 0.448 (p= 0.699), IMN at 0.426 (p= 0.627), VA at 0.308 (p= 0.014), MEF at 0.235 (p= 0.0001), ORIF at 0.190 (p= 0.0001), and CAS at 0.139 (p= 0.001).

DISCUSSION AND CONCLUSION: This study found vascularized allograft, Ilizarov fixation, and cortical allograft struts to be viable alternatives to traditional ORIF in terms of union rates. These alternative modalities do have slightly higher complication rates but may be useful in scenarios involving shortening due to bone loss or atrophic nonunion. ORIF with compression plating, however, remains the gold standard in management of failed union in humeral shaft fractures, while IMN shows the highest reported rate of secondary failure in this context.