Comparison of Initial Nonoperative and Operative Management of Radial Nerve Palsy Associated With Acute Humeral Shaft Fractures

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educational objectives

As a result of reading this article, physicians should be able to:

1. Become familiar with the available treatment approaches for radial nerve palsy associated with humeral shaft fractures.

2. Understand the strengths and limitations of the current treatment approaches for radial nerve palsy associated with humeral shaft fractures.

3. Become familiar with the available evidence regarding the effectiveness of operative and nonoperative treatment for radial nerve palsy associated with humeral shaft fractures.

4. Understand when operative or nonoperative management of radial nerve palsy associated with humeral shaft fractures may be appropriate.

ABSTRACT

The optimal treatment approach for the initial management of radial nerve palsy associated with humeral shaft fractures has yet to be conclusively determined. The authors performed a systematic review of the literature to identify studies that compared the outcomes after initial nonoperative and operative management for radial nerve palsy associated with acute humeral shaft fractures. A meta-analysis of the data from these studies was also performed to determine whether recovery from radial nerve palsy was more favorable in one ap-
Humeral shaft fractures are typically the result of direct trauma and account for 1% to 7% of all fractures. A common complication of humeral shaft fractures is radial nerve palsy, which may occur at the time of injury or during reduction. Radial nerve palsy can be complete or partial and has been reported as a complication for between 2% and 17% of all humeral shaft fractures. The optimal strategy for the initial management of radial nerve palsy associated with humeral shaft fracture has yet to be conclusively determined and remains a controversial issue among surgeons.

The initial management of radial nerve palsy associated with humeral shaft fractures may be nonoperative or operative. Potential advantages of an initial nonoperative approach include the fact that radial nerve palsy often resolves spontaneously and that it avoids the risk of complications that may occur with surgery. Furthermore, proponents of an initial nonoperative approach suggest that delaying surgical exploration does not affect the outcome and that surgical treatment is easier once the fracture has healed. Potential advantages of an initial operative approach include the ability to define the extent and nature of the nerve injury (eg, nerve entrapment), the ability to stabilize the fracture, technical ease (vs later surgical exploration), and a reduced risk of nerve envelopment by scar tissue.

Several nonrandomized, controlled studies have directly compared outcomes following initial nonoperative and operative management of radial nerve palsy associated with acute humeral shaft fractures, but no prospective, randomized trials have been performed. A meta-analysis examining this issue has been published; however, the analyses did not exclusively compare the 2 types of initial management approaches. Hence, the current authors performed a systematic review of the available literature and then performed a meta-analysis of the data to determine whether recovery from radial nerve palsy was more favorable using one management approach over the other.

**Materials and Methods**

**Literature Search Strategy**

The authors searched Medline (inception to August 22, 2011), PubMed (inception to August 22, 2011), and the Cochrane Library (inception to August 22, 2011) using the terms *radial nerve palsy, humeral shaft fracture, proximal humeral fractures, midshaft humeral fractures, distal humeral fractures, operative treatment, nonoperative treatment, functional bracing, intramedullary locking nail, locking plating, and surgical treatment*. A cross-reference bibliography check was performed to ensure a complete list of potential studies. Only English-language studies were evaluated.

**Selection Criteria**

**Studies.** All randomized or quasirandomized (eg, allocation by hospital record number) studies that compared operative and nonoperative management of radial nerve palsy associated with traumatic humeral shaft fractures (ie, proximal, mid-shaft, and distal) were included. Nonoperative and operative treatment for radial nerve palsy associated with traumatic humeral shaft fractures were included. Pharmacological trials were excluded.

**Outcomes.** All clinical outcomes, including degree of nerve functional recovery, degree of fracture recovery (ie, complete, partial, or none), complications (eg, secondary neurolysis, malunion, and infection), free shoulder mobility (eg, range of motion), and complaints, were included.

**Data Extraction and Quality Assessment**

Eligible studies were selected by the first author (G.L.) and one reviewer (H.W.) using the search strategy and criteria already described. The initial decision on trial eligibility was based on citation details and, where available, the title. The following data were extracted from each eligible study: author’s last name; patient characteristics (ie, number, age, sex), type of injury that caused fracture (ie, high- or low-energy), fracture location and type; primary radial nerve palsy (ie, partial or complete), primary treatment, and length of follow-up. The main outcome, primary outcome, and secondary outcomes reported were collected. Qualitative details and raw data describing the study groups, interventions, complications (eg, secondary operation, infection, radial nerve paresis, and nonunion), and complaints, were also recorded. Quality assessment of the extracted data was performed by the reviewer by referring to a previously described approach with modification.

**Data Analysis**

The authors used the [R] “rmeta” package (Free Software Foundation, Inc, Boston, Massachusetts) to perform the meta-analysis. Odds ratios (OR) and 95% confidence intervals (CIs) were determined for each study to assess the effect of treatment on functional recovery from radial nerve palsy associated with traumatic humeral nerve fracture. Functional recovery included whether
full recovery (yes vs no) or free shoulder mobility (yes vs no) was obtained. Results from individual studies were combined using a fixed-effects model (Mantel-Haenszel) and a random-effects model (DerSimonian-Laird) to determine overall OR and 95% CI. Identical analysis was also performed to assess the effect of treatment on complaints after treatment (ie, whether complaints were more or less likely to occur. Complaints of different treatments included secondary neurolysis (yes vs no), malunion (yes vs no), and infection (yes vs no). Heterogeneity across the studies was determined by assessing the Q statistic. Funnel plots were constructed to assess publication bias. Statistical significance was indicated by a P value less than .05.

RESULTS

Literature Search

A total of 935 articles were identified by searching the 3 databases (Figure 1). Of these articles, 591 were subsequently excluded after title review. Abstracts for the remaining 196 articles were reviewed, and 185 were excluded. Hence, 9 articles were included in the systematic review and meta-analyses.10-18

Study Characteristics

Table 1 summarizes the characteristics of all studies included in the meta-analyses. The studies were published between 1972 and 2011 and included 1 prospective study13 and 8 retrospective studies.10-18 No randomized, controlled trials were included in the analyses. The studies included a total of 620 patients: 239 who received nonoperative treatment and 381 who received operative treatment. The quality of trial methodology was generally poor (Table 2).

Primary Outcome: Recovery From Radial Nerve Palsy

A significant effect favored operative treatment in 2 studies. In the Packer et al15 study, the OR of having a favoring outcome during the initial operation was 12.80 (95% CI, 2.02-81.12). Denard et al11 also observed that initial operation was associated with better recovery (OR=4.50; 95% CI, 2.13-9.50). However, the overall fixed-effects model revealed that neither treatment approach was significantly favored over the other (OR=1.09; 95% CI, 0.73-1.64) (Figure 2). The random-effects model findings were consistent with the fixed-effects model findings (overall OR=0.88; 95% CI, 0.27-2.88) (Figure 3). Tests for heterogeneity were not statistically significant for either model (fixed-effect: $\chi^2 [8]=39.73; P=.001$; random-effect: $\chi^2 [8]=39.61; P=.001$).

Secondary Outcome: Complaints

Six of 9 studies compared the complaints between operative and nonoperative treatments. To assess whether initial operation increased complaints compared with nonoperation, the authors further assessed the association of complaints between different treatments. The overall fixed effects model revealed that nonoperative treatment was associated with a decreased risk of complaints (OR=0.50; 95% CI, 0.27-0.85) (Figure 4). A similar finding was observed using the random-effects model (Figure 5). Tests for heterogeneity were not statistically significant for either model (both: $\chi^2 [5]=2.92; P=.713$).

Publication Bias

Funnel plots revealed no strong evidence of publication bias for either the fixed-effects or random-effects models.
The authors performed a systematic review and subsequent meta-analysis of data extracted from eligible studies to compare outcomes following initial nonoperative and operative management of radial nerve palsy associated with acute humeral shaft fractures. A total of 9 studies, involving a total of 620 patients, were identified. Meta-analysis of data extracted from these studies showed that no significant difference in recovery from radial nerve palsy between the initial management approaches and that nonoperation was associated with a decreased risk of complaints.

The current finding that recovery from radial nerve palsy did not significantly differ between the 2 management approaches is consistent with the finding from a previous systemic review. In contrast to the current analyses, Shao et al did not exclusively include data from studies directly comparing nonoperative and operative management. However, they found no significant difference in the rate of recovery between the initial expectant group (nonoperative group) and the early operation group (operated on within 3 weeks after injury).

The current findings are also consistent with those reported in the only prospective study that compared the outcomes of nonoperative and operative management of radial nerve palsies following acute humeral shaft fractures. A total of 9 studies, involving a total of 620 patients, were identified. Meta-analysis of data extracted from these studies showed that no significant difference in recovery from radial nerve palsy between the initial management approaches and that nonoperation was associated with a decreased risk of complaints.

Table 1
Summary of Patients' Baseline Characteristics for Each Study Included in the Meta-analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Age Range, y</th>
<th>No. of Women/Men</th>
<th>No. of Low-/High-Energy Injuries*</th>
<th>Fracture Location (No.)</th>
<th>Fracture Type (No.)</th>
<th>Primary Radial Nerve Palsy</th>
<th>Primary Treatment (No.)</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packer et al</td>
<td>31</td>
<td>5-88</td>
<td>15/16</td>
<td>25/6</td>
<td>Proximal (5) Middle (22) Distal (4)</td>
<td>Closed (31)</td>
<td>Complete (24) Partial (7)</td>
<td>Unclear op method (24) Nonop (7)</td>
<td>1-24 mo</td>
</tr>
<tr>
<td>Bostman et al</td>
<td>59</td>
<td>13-79</td>
<td>14/45</td>
<td>24/35</td>
<td>Proximal (1) Middle (30) Distal (28)</td>
<td>Open (10) Closed (49)</td>
<td>Complete (59)</td>
<td>Unclear op method (39) Nonop (20)</td>
<td>3 y</td>
</tr>
<tr>
<td>Sonneveld et al</td>
<td>17</td>
<td>3-74</td>
<td>7/10</td>
<td>12/5</td>
<td>Middle (16) Distal (1)</td>
<td>Closed (16) Open (1)</td>
<td>Complete or partial (17)</td>
<td>Dynamic compression plate (op) (14) Collar and cuff (nonop) (3)</td>
<td>3-36 mo</td>
</tr>
<tr>
<td>Wallny et al</td>
<td>89</td>
<td>11-92</td>
<td>39/50</td>
<td>NA</td>
<td>Proximal (43) Middle (39) Distal (7)</td>
<td>NA</td>
<td>Complete or partial (12)</td>
<td>Locking nails (op) (45) Functional bracing (nonop) (44)</td>
<td>1-4 y</td>
</tr>
<tr>
<td>Osman et al</td>
<td>104</td>
<td>17-103</td>
<td>44/60</td>
<td>68/36</td>
<td>Primary (31) Middle (54) Distal (19)</td>
<td>NA</td>
<td>Complete or partial (11)</td>
<td>Plates, wires, or nail (op) (72) Sling and plaster splint (nonop) (32)</td>
<td>18 mo</td>
</tr>
<tr>
<td>Ekholm et al</td>
<td>33</td>
<td>16-91</td>
<td>19/14</td>
<td>23/10</td>
<td>Proximal (3) Middle (18) Distal (12)</td>
<td>Closed (33)</td>
<td>Complete or partial (33)</td>
<td>Plate, nail, or screw (op) (15) Nonop (18)</td>
<td>6 y</td>
</tr>
<tr>
<td>Ekholm et al</td>
<td>27</td>
<td>16-91</td>
<td>18/9</td>
<td>17/10</td>
<td>Distal (27)</td>
<td>Closed (27)</td>
<td>Complete or partial (6)</td>
<td>Plate, nail or screw (op) (7) Nonop (20)</td>
<td>6.3 y</td>
</tr>
<tr>
<td>Denard et al</td>
<td>213</td>
<td>Mean: 36.4 (nonop) vs 34.9 (op)</td>
<td>97/116</td>
<td>95/118</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Compression plating (op) (150) Functional bracing (nonop) (63)</td>
<td>3-41 mo</td>
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<td>Van Middendorp et al</td>
<td>47</td>
<td>17-86</td>
<td>23/24</td>
<td>NA</td>
<td>Middle (47)</td>
<td>NA</td>
<td>Primary (3)</td>
<td>Locking nails (op) (33) Functional brace (nonop) (14)</td>
<td>1 y</td>
</tr>
</tbody>
</table>

Abbreviation: NA, not available; nonop, nonoperative; op, operative.
*High-energy injury: traffic accident; low-energy injury: fall, sport injury, etc.
Figure 2: Effect of operative treatment on full recovery of humeral shaft fractures in a fixed-effect model. Fixed-effects (Mantel-Haenszel) meta-analysis included the findings from 9 studies. The odds ratio (OR) and upper and lower 95% confidence intervals (CIs) are shown for each study and for all studies combined (summary). The overall effect of treatment was not statistically significant (OR = 1.09; 95% CI = 0.73-1.64). Test for heterogeneity: $\chi^2(8) = 39.73$ ($P < .001$).

Figure 3: Effect of operative treatment on full recovery of humeral shaft fractures in a random-effects model. Random-effects (DerSimonian-Laird) meta-analysis included the findings from 9 studies. The odds ratio (OR) and upper and lower 95% confidence intervals (CIs) are shown for each study and for all studies combined (summary). The overall effect of treatment was not statistically significant (OR = 0.88; 95% CI = 0.27-2.88). Test for heterogeneity: $\chi^2(8) = 39.61$ ($P < .001$). Estimated random-effects variance = 2.26.

Table 2: Methodological Quality Assessment Scheme for Trials Included in the Meta-analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Treatment Concealed</th>
<th>Withdrawn Partic</th>
<th>Baseline Charac</th>
<th>Outcome Assessors</th>
<th>Partic</th>
<th>Treatment Providers</th>
<th>Care Programs Identical</th>
<th>Inclus/Exclus Criteria</th>
<th>Outcome Measures</th>
<th>Active Surveillance</th>
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<tr>
<td>Packer et al15</td>
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<td>0</td>
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<td>0</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Bostman et al10</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
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<td>Sonneveld et al16</td>
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<tr>
<td>Wallny et al18</td>
<td>1</td>
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<tr>
<td>Osman et al14</td>
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<tr>
<td>Ekholm et al12</td>
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<tr>
<td>Denard et al11</td>
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<td>van Middendorp et al17</td>
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</tbody>
</table>

Abbreviations: Charac, characteristics; Exclus, exclusion; Incl, included; Inclus, inclusion; Partic, participants; Surveill, surveillance.

*Methodological quality assessment was performed using a modified approach based on the method described by Handoll and Ollivere; 0 = quasi-randomized or open list/tables; 1 = small but possible chance of disclosure of assignment or unclear; 3 = method did not allow disclosure of assignment.*

*Treatment concealed before allocation.*

*Withdrawn participants included in analyses and all participants analyzed according to the group allocated at randomization.*

*Baseline characteristics reported and comparable.*

*Care programs, other than trial options, identical.*

*Inclusion/exclusion criteria defined.*

*Outcome measures other than trial options, identical.*

*Active surveillance of appropriate duration.*
A prospective study published to date, which compared outcomes following management of humeral midshaft fractures. Although the patients treated operatively in that prospective study had more favorable outcomes in terms of shoulder abduction strength, elbow flexion strength, functional hand positioning, and return to recreational activities after 6 weeks, no statistically significant differences were found between the 2 management approaches for any of the outcome measures at 1-year follow-up.

Recovery from radial nerve palsy may be affected by several factors, includ-
ing the cause of injury, extent of nerve injury, and location and type of fracture. Unfortunately, an insufficient number of patients in the current study did not allow the authors to perform meaningful subgroup analyses to determine whether the outcome of initial management is affected by these factors. A large-scale, randomized, controlled trial is needed to more comprehensively ascertain which patients with radial nerve injury associated with humeral shaft fractures are more likely to benefit from nonoperative initial management and which patients are more likely to benefit from initial operative management. The small-scale observational studies conducted to date do not allow for definitive conclusions to be drawn.

The results of the current meta-analyses are limited by several factors, most of which relate to the available evidence. First, the quality of the studies included was relatively low. Only a small number of studies were identified, and none were randomized, controlled trials. Second, the specific nonoperative and operative management approaches varied between studies (plate, nail, or undefined operative method) (Table 1), potentially reducing the ability to detect differences between management approaches. Third, only English-language studies were included in the meta-analyses; thus potentially pertinent studies published in the non-English-language journals may have been missed.

**CONCLUSION**

The findings from the current systematic review and subsequent meta-analysis suggest that recovery from radial nerve palsy associated with acute humeral shaft fractures is not significantly influenced by the initial management approach (nonoperative or operative). Although instances of radial nerve palsy should be considered on a case-by-case basis, the authors suggest that initial nonoperative management should be favored when possible due to the reduced risk of complications associated with nonoperative management. Given the potential advantages of initial expectancy and to avoid unnecessary surgery, Shao et al. recommended that a policy of initial expectant management must be considered. Nonoperative management, such as functional bracing, was also advocated in other reports. However, operative intervention is warranted if radial nerve palsy has not resolved within 6 months of the initial injury.5,6

**REFERENCES**


