

# Humeral Shaft Fractures and Radial Nerve Palsy: To Explore or Not to Explore... That Is the Question

Matthew W. Heckler, DO, and H. Brent Bamberger, DO

## Abstract

Humeral shaft fracture with radial nerve palsy has been a subject of debate since this entity was originally described by Holstein and Lewis in 1963. As the literature provides support for almost any approach in treating patients with this injury, surgeons have no definitive literary guidance. To clarify how physicians are actually treating these patients, we surveyed practice tendencies in observation versus exploration of the radial nerve. In addition, we have integrated our survey results with the current literature to propose an algorithm directing treatment of these patients.

Approximately 3% to 18% of humeral shaft fractures are associated with radial nerve palsy.<sup>1-19</sup> Anatomically, the radial nerve is separated from bone throughout its course but is in direct humeral contact along the lateral supracondylar ridge. Holstein and Lewis<sup>1</sup> found the nerve to be vulnerable to injury at this point by a spiral humerus fracture of the distal third (Figure 1). Subsequently, Pollock and colleagues<sup>11</sup> found radial nerve palsy associated with middle-third humerus fractures (60%) more often than with distal-third fractures (28%). These patients commonly present with “low palsy” consisting of decreased dorsal first web space sensation, inability to supinate the forearm, or inability to extend the wrist and digits. However, cases of “high radial nerve palsy” have been reported.<sup>20</sup>

Isolated humeral shaft fractures have traditionally been treated nonoperatively with good results. Such treatment may include a coaptation splint, Velpaeau dressing, collar and cuff, or hanging arm cast. Accepted operative indications for humeral shaft fractures without palsy are more than 20° of angulation anterior/posterior, more than 30° of varus/valgus, more than 3 cm of shortening, severe bone loss, inability to maintain a reduction, closed head injury,

open fracture, associated vascular injury, floating elbow, polytrauma, and intra-articular extension.<sup>21-23</sup> Standard operative treatment for humeral shaft fracture has traditionally been open reduction and internal fixation with plates and screws; this treatment allows for direct fracture reduction, visualization of the radial nerve, and stable fixation without violation of the rotator cuff.<sup>21-23</sup>

Alternative treatments include flexible nails, external fixation, and intramedullary nailing. Advocates of intramedullary nailing emphasize the advantages of using indirect reduction techniques with minimal soft-tissue disruption to achieve improved fixation biomechanics.<sup>21-23</sup> However, cases of radial nerve entrapment at the fracture site have been reported, leading many authors to state that the benefits of direct nerve visualization far outweigh the potential biomechanical advantages of a load-sharing implant.<sup>20,24</sup>

Ultimately, the ideal treatment for radial nerve palsy associated with humeral shaft fracture has been the subject of debate since this entity was originally described. To clarify how physicians are actually treating these patients, we surveyed practice tendencies in observation versus exploration of the radial nerve. In addition, we have integrated our survey results with the current literature to propose an algorithm directing treatment of these patients.

Dr. Heckler is Resident, and Dr. Bamberger is Program Director, Orthopedic Surgery, Grandview Hospital, Ohio University, Dayton, Ohio.

Address correspondence to: H. Brent Bamberger, DO, Orthopedic Surgery, Grandview Hospital, Ohio University, 405 Grand Ave, Dayton, OH 45405 (tel, 937-226-3248; e-mail, heck\_35@hotmail.com).

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**Figure 1.** Anteroposterior (A) and lateral (B) radiographs show the classic “Holstein–Lewis fracture,” a displaced spiral/distal-third humerus fracture.

## MATERIALS AND METHODS

We surveyed physicians in 3 groups: American Society of Surgery of the Hand (ASSH), Orthopaedic Trauma Association (OTA), and a group of orthopedic surgery residents. Each group was asked a series of questions (Table I) pertaining to the treatment of humeral shaft fracture with associated radial nerve palsy.

The groups were assessed independently and anonymously through an online survey program (www.surveymonkey.com). All ASSH members and all current osteopathic orthopedic surgery residents were e-mailed a linked invitation to participate in the survey; all OTA members received their invitation with their seasonal newsletter. Each respondent was allowed to respond to the survey only once, and that response was collected and tallied by the online survey program.

## RESULTS

From the 3 groups, approximately 2650 physicians total were invited to participate in this survey. Overall, 558 surgeons responded (Table II). For an adult patient without palsy, the 3 groups agreed that plate and screws are the implant of choice when fixation is indicated in a closed neurovascularly intact midshaft humerus fracture (Table II). Similarly, the groups agreed that open humeral shaft fractures with radial nerve palsy should be explored (Table III). Regarding the closed “Holstein–Lewis fracture,” 39% of respondents remained neutral. Yet, 60% of physicians and

all organizations agreed that this fracture is not a primary indication for exploration (Table IV).

Interestingly, there was significant disagreement regarding treatment of patients with a secondary palsy (Table V). Overall, 65% of respondents agreed with initial exploration for secondary palsies, but the percentage was much higher for ASSH members (71%) than for OTA members (47%) and residents (41%); that is, most ASSH members were aggressive in recommending exploration, whereas most OTA members and residents either were neutral or favored observation of these injuries.

## DISCUSSION

The literature provides support for almost any approach in treating patients with humeral shaft fracture and radial nerve palsy. Many authors have advocated nerve exploration in these patients.<sup>1,5-8,10,14,18,19</sup> Reflecting the relatively uncommon nature of this injury, most of the literature consists of anecdotal information, case reports, and extended case series. Interestingly, many of the authors who have advocated early exploration found an intact nerve on identification. For example, Packer and colleagues<sup>10</sup> found only 2 of 31 fractures with radial nerve palsy to have a *lacerated* or *impaled* nerve. Most of the explored nerves in the study by Packer and colleagues and in other studies have been described as *stretched*, *entrapped*, *contused*, or *crushed*. The result-

**Table I. Questions Pertaining to Treatment of Humeral Shaft Fracture With Associated Radial Nerve Palsy**

**What type of orthopedic practice do you have?**

1. Resident/fellow
2. General
3. Hand and upper extremity
4. Trauma

**In general, when considering surgical fixation of a closed neurovascularly intact midshaft humeral diaphysis fracture in an adult, what is your implant of choice?**

1. Plate and screws
2. Intramedullary nail
3. Flexible nail
4. External fixation
5. Other

**Open humeral shaft fracture with radial nerve palsy should be explored**

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

**Closed “Holstein–Lewis fracture,” spiral/distal-third in nature, should be explored**

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

**Secondary palsy (palsy after reduction or casting) of the radial nerve should be explored**

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

**Table II. Implant of Choice**

	Total	ASSH	OTA	Residents
Plate and screws	373 (67%)	278 (65%)	75 (74%)	20 (69%)
Intramedullary nail	144	114	22	8
Flexible nail	11	6	5	0
External fixation	1	1	0	0
Other	22	21	0	1
No response	7	7	0	0
Totals	558	427	102	29

Abbreviations: ASSH, American Society of Surgery of the Hand; OTA, Orthopaedic Trauma Association.

**Table III. Open Humeral Shaft Fracture With Radial Nerve Palsy Should Be Explored**

	Total	ASSH	OTA	Residents
Agree/strongly agree	481 (86%)	374 (88%)	83 (81%)	24 (83%)
Neutral	36	26	8	2
Disagree/strongly disagree	16	2	11	3
No response	6	6	0	0

Abbreviations: ASSH, American Society of Surgery of the Hand; OTA, Orthopaedic Trauma Association.

**Table IV. Closed "Holstein-Lewis Fracture," Spiral/Distal-Third in Nature, Should Be Explored**

	Total	ASSH	OTA	Residents
Agree/strongly agree	102	76	21	5
Neutral	109	94	15	0
Disagree/strongly disagree	337 (60%)	247 (58%)	66 (65%)	24 (83%)
No response	10	10	0	0

Abbreviations: ASSH, American Society of Surgery of the Hand; OTA, Orthopaedic Trauma Association.

**Table V. Secondary Palsy (Palsy After Reduction or Casting) of the Radial Nerve Should Be Explored**

	Total	ASSH	OTA	Residents
Agree/strongly agree	362 (65%)	302 (71%)	48 (47%)	12 (41.3%)
Neutral	64 (11%)	42 (10%)	19 (19%)	3 (10.3%)
Disagree/strongly disagree	126 (23%)	77 (18%)	35 (34%)	14 (48.3%)
No response	6 (1%)	6 (1%)	0	0

Abbreviations: ASSH, American Society of Surgery of the Hand; OTA, Orthopaedic Trauma Association.

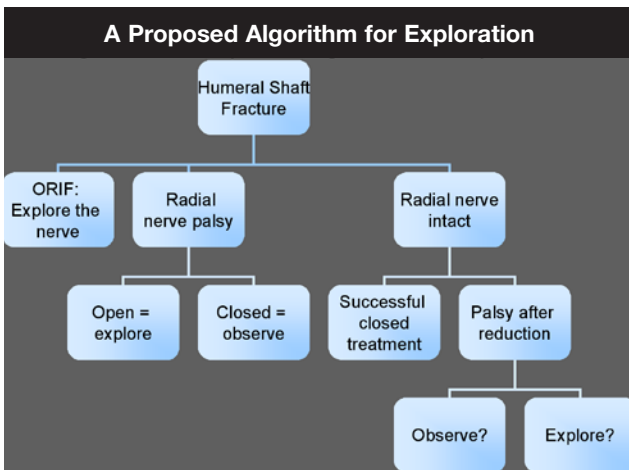
ing question is, "Would these nerves have recovered without exploration?"

In addition, nerve exploration does carry the risk for complications, including wound-healing issues, potential nonunion or delayed union, hardware complications, and iatrogenic nerve injury. Consequently, several authors have recommended observation for most of these injuries.<sup>2-4,9,11-13,15-17</sup> Most authors agree that, if operative fixation is indicated in a patient with radial nerve palsy, the nerve should be explored.<sup>9,25</sup>

Some authors have specifically examined open fractures with radial nerve palsy. Shaw and Bhatti<sup>15</sup> recommended early exploration in affected patients but found that only 1 in 5 explored nerves required neurolysis. Still advocating early exploration of open fractures with palsy, Foster and

colleagues<sup>26</sup> found significantly more morbidity with these injuries; 64% of open humeral fractures with palsy on early exploration had a trapped, partial, or completely lacerated radial nerve. More recently, Ring and colleagues<sup>27</sup> found that 55% of open humerus fractures had transected radial nerves. Consequently, though there are no prospective randomized controlled trials, most authors and the majority of our survey respondents have agreed that open fractures with radial nerve palsy should be explored primarily.

Other authors have specifically examined fracture location, fracture type, and degree of angulation as indicators for nerve exploration with associated palsy. Vansteenkiste and colleagues<sup>28</sup> advocated exploration for all patients with the Holstein-Lewis fracture and palsy after finding a mac-



**Figure 2.** Outline of proposed treatment algorithm for humeral shaft fractures with radial nerve palsy. This algorithm is based on findings from our literature review and physician survey.

roscopic lesion of most nerves in these patients. Böstman and colleagues<sup>3,4</sup> found that longitudinal fractures of the distal third are significantly more likely than transverse fractures of the middle third to have lacerated, interposed, or entrapped radial nerves. Interestingly, they found no significant difference with regard to recovery between exploration versus observation for these patients. Shah and Bhatti<sup>15</sup> found no significant difference in recovery based on fracture level, fracture type, age, or cause of injury in 11 patients with the Holstein–Lewis fracture and palsy. Similarly, most surgeons in our survey did not consider the Holstein–Lewis fracture to be a primary indication for surgery.

**Secondary Palsy.** In the literature, the controversy regarding management of secondary palsy has continued. Authors have advocated both exploration<sup>10,16</sup> and observation.<sup>3,4,9,15</sup> DeFranco and Lawton<sup>29</sup> recently reviewed these injuries and recommended an individualized treatment strategy overall but initial exploration of secondary palsies. Given the relatively uncommon nature of this injury, patient data are derived mostly from small subsets within extended case reports and therefore are limited. With no definitive evidence for or against exploration, many surgeons abide by the statement, “If the nerve is in continuity after the trauma responsible for fracture, it will still be in continuity after whatever subsequent trauma caused the paralysis.”<sup>12</sup> Even common orthopedic textbooks disagree on the treatment of secondary palsy.<sup>21–23</sup> This controversy was found in our survey results as well. ASSH members were more aggressive in advocating early exploration of the radial nerve in patients with secondary palsy, whereas OTA members and residents trended toward initial observation. The basis for these differing approaches is unknown but likely multifactorial: training, personal experience, local practice environment, and patient issues.

The number of respondents in our study is notable, but the online nature of our survey may have influenced its results. First, arriving at an accurate response rate is difficult when survey invitations are e-mailed, computer-generated, or dis-

tributed through a newsletter. Second, results may be biased against surgeons who are not comfortable with computers, e-mail, and the Internet. Nevertheless, our survey results provide insight into trends in surgeons’ treatment of these injuries.

The deficiencies in the literature on our subject are readily apparent, but the primary one is a lack of quality prospective randomized controlled trials. However, in combining the findings from our literature review with those from our survey of practice tendencies, we were able to develop a treatment algorithm (Figure 2). The combined findings support observation for most closed humerus fractures with radial nerve palsy, including the Holstein–Lewis fracture. Exploration of the radial nerve is warranted when bone fixation is indicated. The combined findings trend toward exploration of open humeral fractures with radial nerve palsy. Last, exploration versus observation for a “secondary palsy” is controversial, and support for either can be found in the literature and in current practice tendencies.

## CONCLUSIONS

No prospective randomized controlled trials have been conducted to assess treatments for humerus fractures and radial nerve palsy. However, findings from our literature review and from our survey of practice tendencies can be used to outline treatment trends. Most humeral shaft fractures can be treated nonoperatively, but, when operative intervention is indicated and there is associated radial nerve palsy, exploration of the nerve is warranted. For closed fractures with radial nerve palsy, the incidence of recovery is high, so observation is justified. Evidence trends toward primary exploration of open humerus fractures with radial nerve palsy. Last, exploration versus observation for a “secondary palsy” is controversial, and support for either can be found in the literature and in current practice tendencies.

## AUTHORS’ DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

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