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Consensus statement on the treatment of proximal humerus fractures: a Delphi approach by the Neer Circle of the American Shoulder and Elbow Surgeons

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Background: The treatment of patients who sustain a proximal humerus fracture (PHF) remains controversial. The purpose of this study was to find consensus among experts using a validated iterative process in the treatment of patients after a PHF.
Methods: The Neer Circle is an organization of shoulder experts recognized for their service to the American Shoulder and Elbow Surgeons. Consensus among 86 identified experts from this group was sought with a series of surveys using the Delphi process. The first 3 surveys included vignettes with 2-, 3-, and 4-part fractures, under 2 scenarios: (1) a healthy 55-year-old and (2) and a 75-year-old with significant medical comorbidities. Within each vignette, respondents were asked about their preference on computed tomography (CT) use, and whether they would select operative or nonoperative treatment. A final survey was administered to elicit respondent preferences on general treatment approaches regardless of specific vignette characteristics.
Results: Consensus was reached on the value of CT scans with 3D reconstructions, age as an important factor in determining treatment, functional demand, fracture pattern, bone quality, and the presence of more significant medical comorbidities, all of which would strongly impact decision making. Experts agreed that medial calcar involvement would have no impact on their decision, and gender and nondominant arm involvement would have a low impact. Consensus was reached in the following scenarios for an operative treatment in a young and healthy patient: 2-part shaft fracture (vignette 3, 98%), 3-part varus fracture (vignette 5, 98%), 3-part valgus fracture (vignette 7, 98%), 4-part fracture (vignette 9, 100%), 4-part dislocation fracture (vignette 11, 98%), and 4-part valgus impacted fractures (vignette 13, 95%); for older unhealthy patients, in 4-part dislocation fractures (vignette 12, 100%). In the remainder of scenarios, there was no consensus reached for preferred treatment, either operative or nonoperative. Finally, there was no consensus on preferred rehabilitation protocols, whether for nonoperative management or postoperative care.
Conclusion: In conclusion, this study demonstrates that consensus when managing PHFs is limited to specific scenarios, whereas lack of consensus still exists in others. The presented study advocates nonoperative treatment of PHFs in the sicker patient and surgical treatment methods for 3-part and 4-part fractures in the young, healthy patient.
Level of evidence: Level V; Consensus Development Study; Delphi Method

Keywords: Surgical neck fracture; 2-part shaft fracture; 3-part varus fracture; 3-part valgus fracture; 4-part fracture; 4-part fracture dislocation; 4-part valgus impacted fracture

Proximal humerus fractures (PHFs) are the third most frequent fracture of the elderly and account for approximately 4%-5% of all fractures.[2,23] Because of an aging society with associated high rates of osteoporosis, the incidence of PHF is likely to increase in the future.[15,22] Although most orthopedic and trauma surgeons encounter this common fracture entity, the optimal treatment strategy is still debated. Treatment options range from nonoperative management, fixation with a locking plate, and anatomic or reverse total shoulder arthroplasty.[6]

The patient and radiographic factors that influence the decision making for nonoperative vs. surgical management of PHF have been subject to ongoing debate. In an elderly patient group with a high rate of comorbidities, some authors debate the efficacy of surgical management and recommend nonoperative management in this patient population.[10] However, there appears to be a lack of evidence for optimal nonoperative management. Despite the hesitation of some surgeons to operate on older patients with PHF, epidemiologic studies predict surgery rates to increase by up to 30%.[10,19,25] Surgical treatments used most commonly include reverse total shoulder arthroplasty and open reduction and fixation with a locking plate (LPF).[6] It has not been established which of these 2 surgical treatment options is preferable. Although some authors describe poor fracture reduction, avascular necrosis, varus malunion, and screw cut-out leading to failure rates up to 40% in locking plate fixation, other authors focus on the technical developments including computed tomography (CT) imaging, screw augmentations, medial calcar stabilization by bone grafting, carbon fiber–reinforced locking plates, and an additional medial plate.[1,7] With these technical advances, failure rates have been reported around 9%.[16] However, based on mathematical regression models of inpatients who were treated with a PHF in the United States between 2004 and 2012, rates of reverse total shoulder arthroplasty implantation are projected to increase 100% by 2032.[25]

Given the limited high-level scientific evidence, the purpose of this study is to implement the Delphi technique among the expert panel of the ASES Neer Circle to determine areas of consensus regarding treatment options for PHF. The first aim is to determine radiographic features that influence operative vs. nonoperative treatment of PHF. Second, this study investigates the impact of patient age and fracture type on the resulting treatment strategy. Lastly, this study aims to illustrate the current nonoperative treatment strategy within the Neer Circle.

Methods

Delphi technique

The Delphi approach was developed by the RAND Corporation (Santa Monica, CA, USA) to achieve consensus on topics of controversy.[12] Defining characteristics of the Delphi method are anonymity, multiple rounds of questionnaires, reduction of individual and/or group interests, as well as the controlled opinion feedback.[4,5,12]

Survey process and reporting followed recommendations of the Conducting and REporting DElphi Studies (CREDES) guidelines, which is a part of the Enhancing the QUAlity and Transparency Of health Research (EQUATOR) network.[13] Based on these guidelines, a threshold for consensus was set to 80% prior to the administration of the vignette surveys. Some vignette treatment questions were administered contingent to the respondent's choice of operative or nonoperative care, and such "child" questions were only eligible for consensus consideration when consensus was attained for the "parent" question.

Assembling a panel of experts

The Neer Circle is composed of approximately 120 shoulder and elbow specialists recognized by American Shoulder and Elbow Surgeons (ASES) for their service to the society. This group served as the candidate pool to contribute their expertise via electronic survey participation. Additionally, a Neer Circle Committee for the 2022 Clinical Question consisted of 15-20 surgeons who participated in monthly calls to provide expert guidance on the survey construction, execution, and interpretation processes. Notably, the clinical question subcommittee collaborated systematically to select representative radiographs for each of the vignette fracture patterns.

Participation survey

In November 2021, Neer Circle members were sent a short survey to gauge requisite expertise and willingness to participate in the Delphi process. Several key surgeon characteristics were also captured, including age, gender, practice location (United States, Canada, Europe, other), years in practice, subspecialty training (trauma; sports; hand and wrist; shoulder and elbow), whether they currently supervise trainees, and type of practice (academic, community, private, other). Additionally, respondents were asked to estimate the number of PHFs they treat per year, and to break down the percentages of PHF cases by treatment approach. Lastly, respondents were asked to rank order patient characteristics (12 options provided and "other" field available for write-in responses) in terms of relative importance for making treatment decisions. This information was used to guide future survey question creation in the patient vignette phase. Respondents that expressed willingness and suitable expertise were sent all future surveys. Data regarding surgeon demographics and practice characteristics were used for summary purposes only. To satisfy the Delphi guideline of respondent anonymity, these factors were not linkable to subsequent treatment preferences expressed during the patient vignette phase.

Vignette surveys

Three rounds of patient vignette surveys were administered throughout the Winter and Spring of 2022. The first, second, and third vignette surveys were included 2-part, 3-part, and 4-part fractures, respectively. Surveys 1 and 2 each included 2 distinct fracture patterns, whereas survey 3 included 3 distinct fracture patterns. Each of the 7 fracture patterns were considered under 2 scenarios: (1) a healthy 55-year-old and (2) and a 75-year-old with significant medical comorbidities such as chronic obstructive pulmonary disease, coronary artery disease, chronic renal failure, obesity, osteopenia, or drug/alcohol abuse. The baseline scenario for each of the 14 resultant vignettes specified a female patient with injury to their dominant arm who has a good social support system and enjoys light activity such as reading and playing cards. A descriptive breakdown of the vignette surveys can be found in Table I and Figure 1.

Within each vignette, respondents were asked about their preference on CT use, and whether they would select operative or nonoperative treatment. From there, respondents branched into either a nonoperative or operative question pathway. Subsequent questions interrogated preferences for physical therapy, patient monitoring, and whether patient or radiographic factors would influence a change in their original operative/nonoperative decision. A diagram illustrating the question flow is included as Figure 2 and the Supplementary Appendix S1 includes the portion of survey 1 that pertains to vignette 1.

Final survey

A final survey was administered in Summer 2022 to elicit respondent preferences on general treatment approaches regardless of specific vignette characteristics.

Results

The initial survey sent to all members of the Neer Circle demonstrated that 86 of 91 members (95%) had adequate experience in the management of PHFs and would participate in the current study. Response rates were consistently high, never dropping below 75%. Demographic data of the study participants were ascertained. Sixty-two (83%) practiced in the United States. The majority of the participants at the time of the survey had been practicing for more than 16 years (16-20 years: 13% [10/75]; ≥20 years: 71% [53/75]). Subspecialty training among the respondents included 88% shoulder and elbow (64/73), 40% sports (29/73), 10% hand and wrist (8/73), and 8% trauma (6/73). Sixty-one percent (45/74) practiced at an academic institution, with the remainder working in private practice (26% [19/74]), a community setting (6% [4/74]), or other practice environment (8% [6/74]). Half of the respondents (50% [37/74]) attested to treating ≥20 PHFs per year, whereas 43% (32/74) treat approximately 6-20 per year.

For the scenario in vignette 2, an older, unhealthy patient with a 2-part varus displaced fracture, 81% of respondents agreed they would not order a CT scan, and 95% of

Table I Listing of patient and injury characteristics for each of 14 vignettes administered to the expert opinion panel

Survey	Vignette	Pattern	Age, yr	Health
Survey 1: 2-part fractures	1	Varus Fx	55	Healthy
Survey 1: 2-part fractures	2	Varus Fx	75	Unhealthy
Survey 1: 2-part fractures	3	Translated shaft	55	Healthy
Survey 1: 2-part fractures	4	Translated shaft	75	Unhealthy
Survey 2: 3-part fractures	5	Varus Fx	55	Healthy
Survey 2: 3-part fractures	6	Varus Fx	75	Unhealthy
Survey 2: 3-part fractures	7	Valgus Fx	55	Healthy
Survey 2: 3-part fractures	8	Valgus Fx	75	Unhealthy
Survey 3: 4-part fractures	9	Fx	55	Healthy
Survey 3: 4-part fractures	10	Fx	75	Unhealthy
Survey 3: 4-part fractures	11	Fx dislocation	55	Healthy
Survey 3: 4-part fractures	12	Fx dislocation	75	Unhealthy
Survey 3: 4-part fractures	13	Valgus impacted Fx	55	Healthy
Survey 3: 4-part fractures	14	Valgus impacted Fx	75	Unhealthy

Fx, fracture.

respondents agreed to treat this patient nonoperatively. No consensus was reached for timing of follow-up radiographs, the preferred therapy approach (eg, formal vs. self-directed), timing of initiating active or passive range of motion, or maximum acceptable varus or apex anterior angulation. Additionally, there was no consensus on the patient factors that would have a high impact on the decision to switch to operative treatment. Finally, when considering a change in treatment routes, there was agreement that male gender (87%), nondominant arm involvement (83%), and medial calcar comminution (80%) would have a low impact on decision making.

A consensus was reached for ordering a preoperative CT scan for young, healthy patients with a 2-part shaft fracture (82%), 3-part valgus fracture (90%), 4-part fracture (90%), 4-part fracture-dislocation (82%), and 4-part valgus impacted fracture (81%). For those who chose CT in scenarios involving the young patients with 2-part shaft and 3-part valgus fractures, the reasons of highest significance in this decision were ‘‘for surgical planning’’ (81%; 95%) and ‘‘severity of displacement or involvement of the humeral head,’’ for the 2-part shaft fractures (83%) or ‘‘of the tuberosities,’’ for the 3-part valgus fractures (80%). Among the same group, 85% and 95% agreed that they would prefer 2D imaging and 3D reconstructions for 2-part shaft and 3-part valgus fractures, respectively.

There was a consensus noted for operative treatment for 4-part fracture-dislocations in older, unhealthy patients and for young, healthy patients with a 2-part shaft fracture (98%), 3-part varus fracture (95%), 3-part valgus fracture (98%), 4-part fracture (100%), 4-part fracture-dislocation (98%), or 4-part valgus impacted fracture (95%). In the remainder of scenarios, there was no consensus reached for preferred treatment, either operative or nonoperative. Among those who chose the operative route, fracture pattern (88%-97%) was chosen as having a high impact on this decision in all of the aforementioned scenarios. Age and functional demand were also ranked high for young, healthy patients with a 3-part varus or valgus fracture, 4-part fracture, 4-part fracture-dislocation, or 4-part valgus impacted fracture. Bone quality and better outcomes with surgery were ranked high for young, healthy patients with 3-part varus and 3-part valgus fractures, respectively. Ranked low for importance on decision making were duration of surgery for young, healthy patients with a 3-part varus fracture or 4-part fracture, and ease of surgical technique for young, healthy patients with a 3-part varus fracture.

There was agreement for the use of intraoperative imaging for young, healthy patients with a 2-part shaft fracture (87%), 3-part varus fracture (91%), 3-part valgus fracture (88%), or 4-part valgus impacted fracture (96%). There was, however, no consensus reached on the type of intraoperative imaging. The majority (84%-90%) would use a standard C-arm over the mini C-arm. Of that majority, it was fairly evenly divided between having the imager on the ipsilateral side of the operative table and having it from the head or contralateral side of the table.

The preferred surgical treatment for the vignettes that attained 80% consensus for operative treatment are displayed in Figure 3. Although there was agreement for operative treatment in young, healthy patients with a 2-part fracture through the surgical neck with significant shaft displacement, there was no consensus met regarding the surgical treatment approach. There was agreement that male gender, nondominant arm involvement, and medial calcar comminution would have a low impact on the decision to switch to nonoperative management. No consensus was noted, however, on the patient factors that have a high impact on the decision to switch to nonoperative treatment.

In 3-part varus and valgus fracture in a young, healthy patient, respectively, there was no consensus on surgical treatment approach (Fig. 4). There was, however,

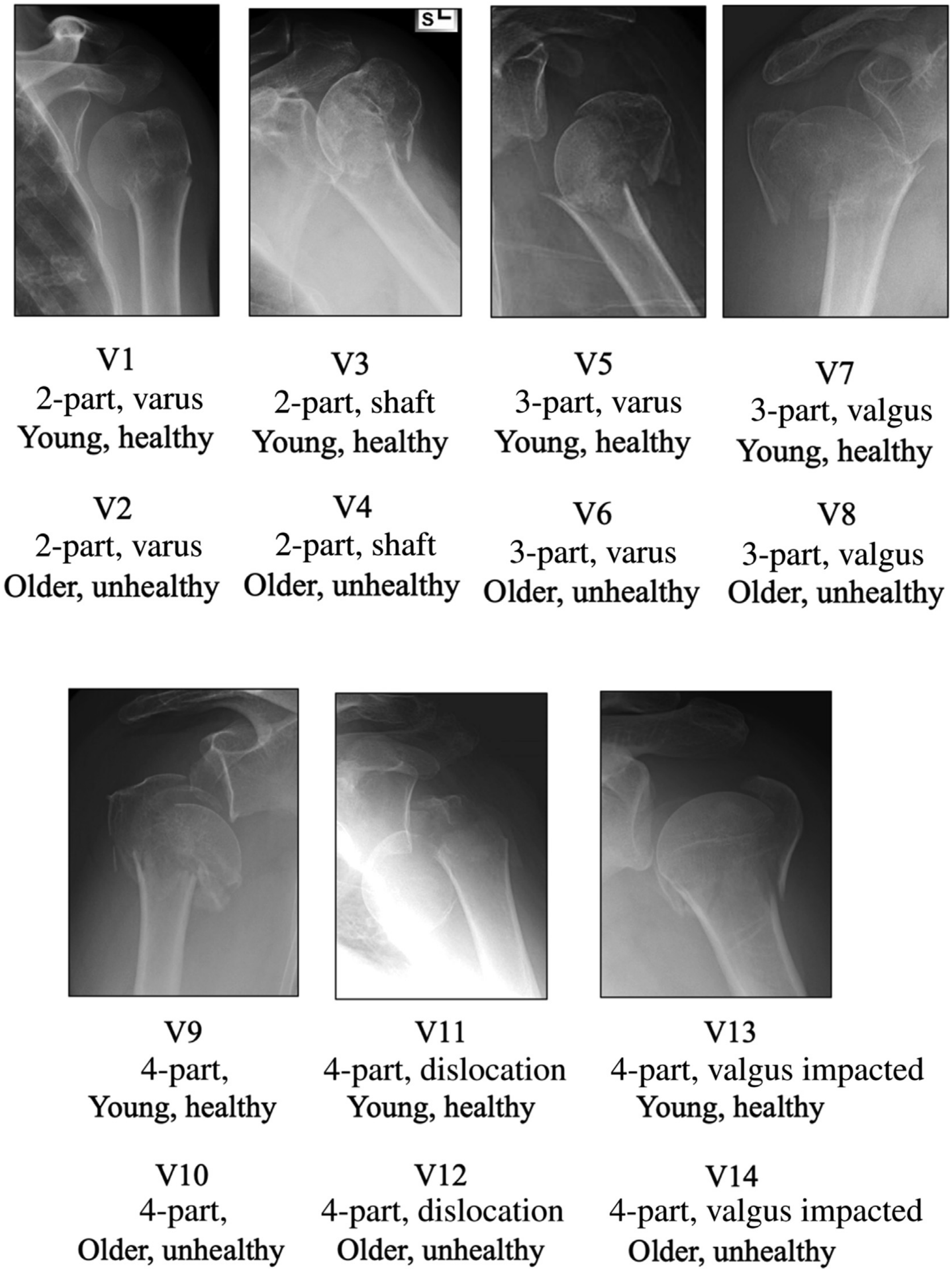

Figure 1 Fourteen vignettes illustrating 7 frequent cases for proximal humeral fractures. Cases are subdivided into 7 cases of young and healthy patients and 7 of old and unhealthy patients

agreement on not performing an arthroplasty procedure in these cohorts. Of the respondents who chose operative treatment, the majority would perform some variation of open reduction and internal fixation (3-part varus 79%; 3-part valgus 75%). Many respondents would use a locking plate construct with rotator cuff sutures incorporated into the fracture fixation (3-part varus 58%; 3-part valgus 63%). Some would use a locking plate in isolation (3-part varus 8%; 3-part valgus 8%), whereas others would augment with a fibular strut/bone graft (3-part varus 13%; 3-part valgus 4%). A consensus of 84% of respondents agreed that ‘‘more significant medical comorbidities’’ would have a high impact on the decision to switch treatment routes. A consensus of respondents would not change treatment

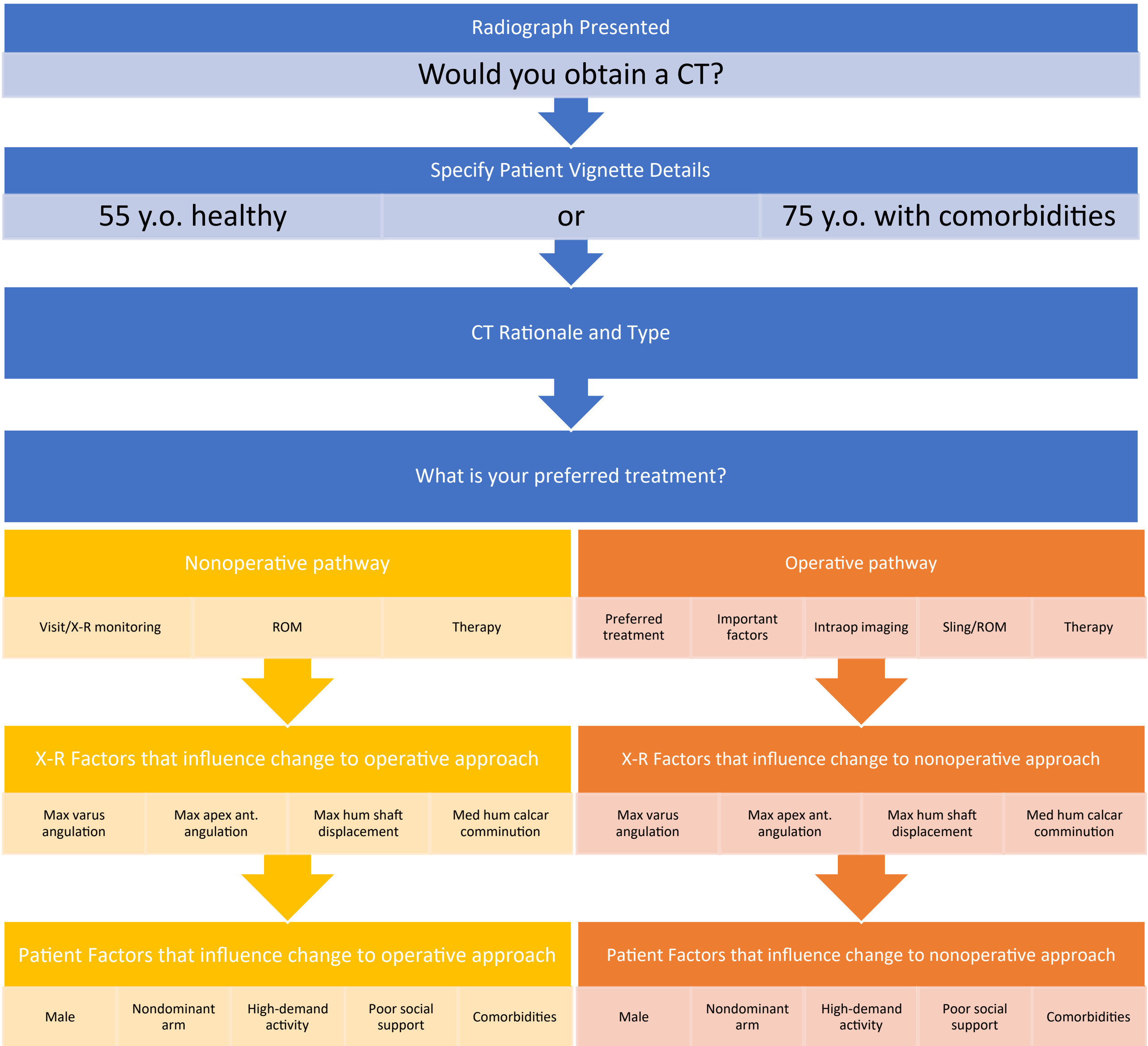

Figure 2 Flow diagram summarizing the questions asked within each patient vignette. Each respondent either goes down the non-operative or operative pathway. The Supplementary Appendix S1 shows each question asked within vignette 1 as an illustration. *CT*, computed tomography; *y.o.*, years old; *X-R*, radiographic; *ROM*, range of motion; *ant.*, anterior; *hum*, humeral; *Med*, medial.

routes based on medial calcar comminution (3-part varus 96%; 3-part valgus 96%) or on the Hertel classification (3-part varus 100%; 3-part valgus 96%).

There was a nearly unanimous consensus of respondents that agreed to operatively treat young, healthy patients with a 4-part fracture, 4-part fracture-dislocation, or 4-part valgus impacted fracture and older, unhealthy patients with a 4-part fracture-dislocation; although, in the presence of significant medical comorbidities, 84% and 89% of respondents agreed they would consider switching to nonoperative management for young, healthy patients with a 4-part fracture and 4-part valgus impacted fracture, respectively. If considering switching treatment routes for older, unhealthy patients with a 4-part fracture-dislocation, 82% agreed that nondominant arm involvement would play a low impact on their decision. There was no consensus reached regarding the surgical treatment approach for a 4-part fracture in a young, healthy patient and a 4-part fracture dislocation in a young, healthy patient. For an older, unhealthy patient with a 4-part fracture dislocation, there was a consensus of 95% of respondents that would perform RSA. Although there was no consensus reached for surgical treatment approach for a 4-part valgus impacted fracture in a young, healthy patient, 60% of respondents did agree that they would perform an open reduction and internal fixation with a locking plate and suture fixation.

There was further inquiry into specific surgical techniques when performing RSA (Fig. 5). A consensus of

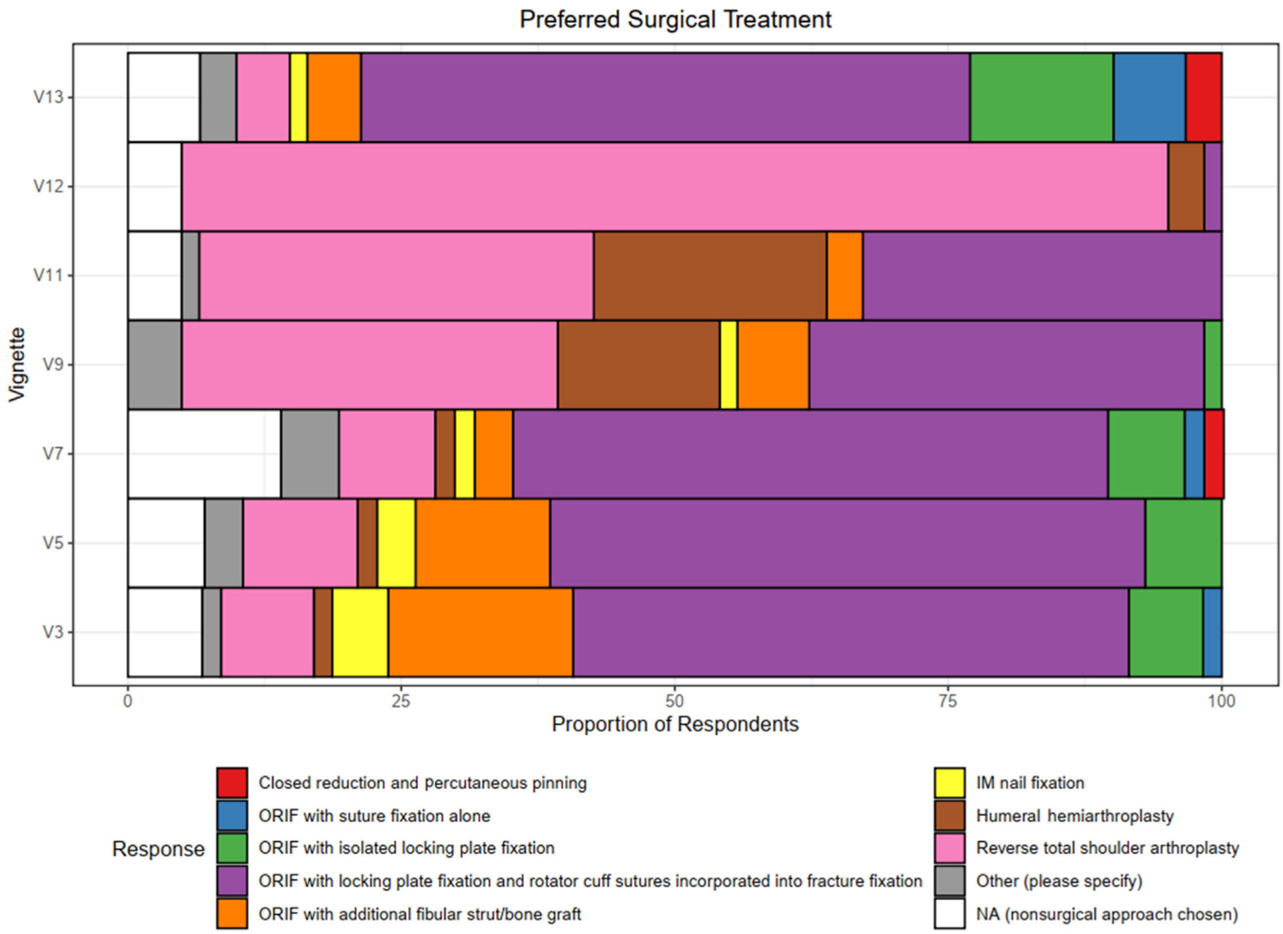

Figure 3 Preferred surgical treatment breakdown by vignette. Only vignettes that attained 80% consensus among respondents for operative treatment are included. *ORIF*, open reduction and internal fixation; *IM*, intramedullary.

Survey	Vignette	Pattern	Age, yr	Health	Obtain CT?	Operative v Nonoperative
Survey 1: 2-part fractures	1	Varus Fx	55	Healthy	No consensus	No consensus
Survey 1: 2-part fractures	2	Varus Fx	75	With medical comorbidities	No (81%)	Nonoperative (95%)*
Survey 1: 2-part fractures	3	Translated shaft	55	Healthy	Yes (82%)	Operative (98%)
Survey 1: 2-part fractures	4	Translated shaft	75	With medical comorbidities	No consensus	No consensus
Survey 2: 3-part fractures	5	Varus Fx	55	Healthy	No consensus (76%)	Operative (98%)
Survey 2: 3-part fractures	6	Varus Fx	75	With medical comorbidities	No consensus	No consensus
Survey 2: 3-part fractures	7	Valgus Fx	55	Healthy	Yes (90%)	Operative (98%)
Survey 2: 3-part fractures	8	Valgus Fx	75	With medical comorbidities	No consensus	No consensus
Survey 3: 4-part fractures	9	Fx	55	Healthy	Yes (90%)	Operative (100%)
Survey 3: 4-part fractures	10	Fx	75	With medical comorbidities	No consensus	No consensus
Survey 3: 4-part fractures	11	Fx dislocation	55	Healthy	Yes (82%)	Operative (98%)
Survey 3: 4-part fractures	12	Fx dislocation	75	With medical comorbidities	No consensus (75%)	Operative (100%)
Survey 3: 4-part fractures	13	Valgus impacted Fx	55	Healthy	Yes (81%)	Operative (95%)
Survey 3: 4-part fractures	14	Valgus impacted Fx	75	With medical comorbidities	No consensus	No consensus

Figure 4 Preferred imaging and treatment breakdown of primary vignettes by the Neer Circle. Vignettes that attained 80% consensus among respondents are marked *green* and those that did not attain 80% consensus are marked *red*. *Fx*, fracture; *CT*, computed tomography.

80%-100% of respondents agreed that in most cases they repair the greater tuberosity, use a deltopectoral approach, repair the lesser tuberosity, use the humeral head for bone grafting under the tuberosities, and perform a biceps tenodesis. A consensus of 80%-100% of respondents agreed that in most cases they perform a biceps tenodesis, do not perform an osteoporosis workup, and do not use a superior approach. There was no consensus reached regarding use of cement, use of a lateralized baseplate/glenosphere construct, or leaving the supraspinatus intact.

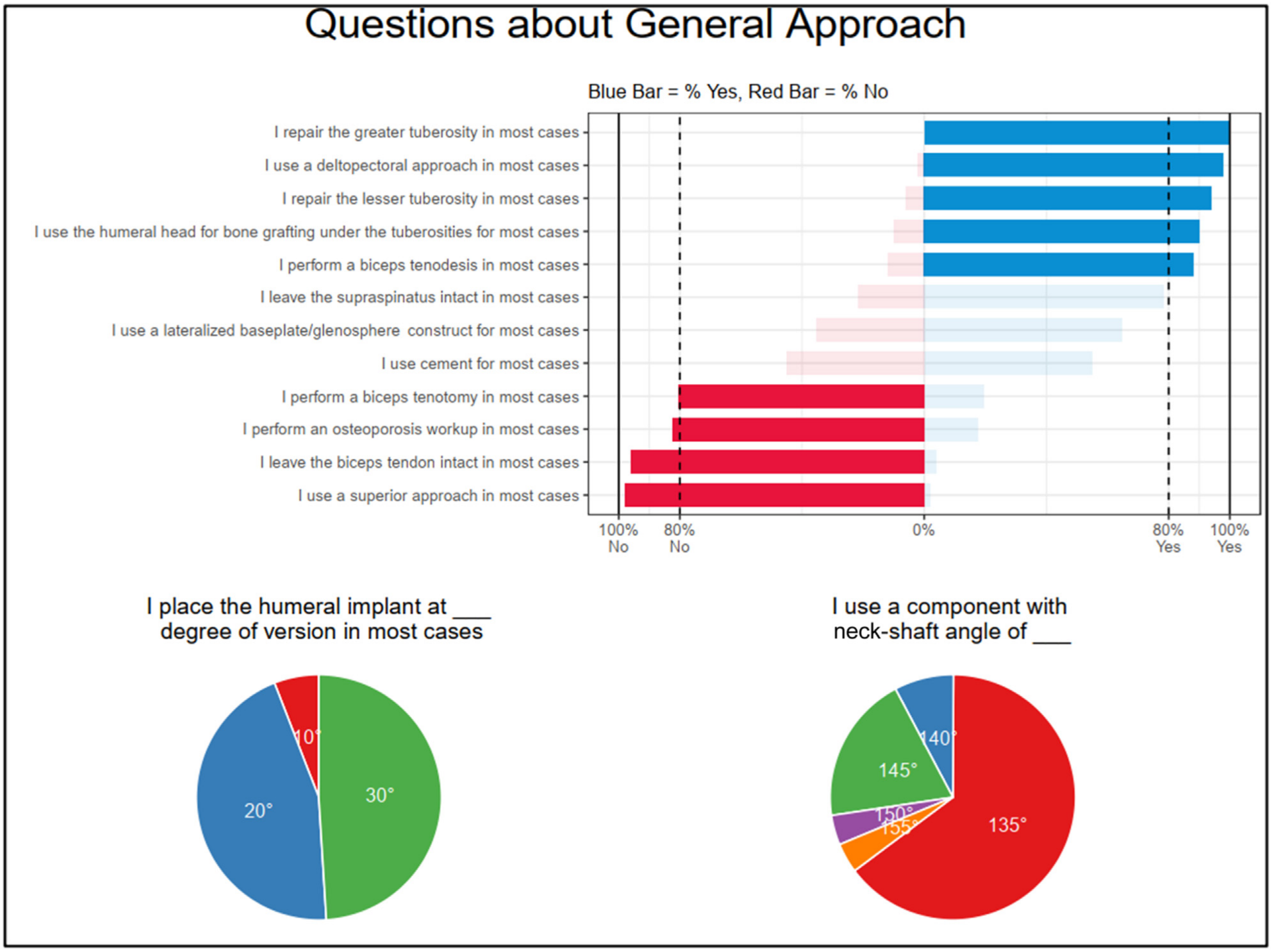

Figure 5 Graphical summary of responses to 14 general treatment preference questions administered as part of the final survey.

More than 90% of participants place the humeral implant at 20° (45%) or 30° (49%) of version. Sixty-five percent of respondents use a component with a neck-shaft angle of 135°, whereas 4% of respondents use one with a 155° neck-shaft angle.

In all of the scenarios, no consensus was reached regarding timing of follow-up radiographs, sling duration, timing of initiation of passive or active range of motion, or preferred therapy method. There was also no agreement regarding the maximum acceptable varus angulation, apex anterior angulation, and shaft displacement, below which the respondents would consider nonoperative treatment.

Final survey

Consensus was attained on several general approach questions administered in the final survey (Fig. 3). More than 80% of respondents generally repair the greater tuberosity, use a deltopectoral approach, repair the lesser tuberosity, use the humeral head for bone grafting under the tuberosities, and perform a biceps tenodesis in most cases. At least 80% of the respondents perform a biceps tenodesis, do not perform an osteoporosis workup, and do not use a superior approach in most cases.

Discussion

The most important findings of this study represent very little consensus on whether a PHF should be treated operatively or nonoperatively in the Neer Circle Panel. The optimal treatment strategy of the PHF is still debated.[8-10,21,23]

Although there is an increase in the rates of surgeries performed, the ProFHER study from Handoll et al[10] questioned the efficacy of a surgical approach.[3,25] A national database study by Sabesan et al[25] found that in the United States from 2004 to 2012, there was a decrease in nonoperative treatment from 65% to 59%. In the current study, although the threshold for consensus was not met, nonoperative management was chosen by roughly 30%-50% of experts in 3 vignettes and by 50%-70% in 3 other vignettes. These data are comparable to the quoted national rate.[25] It is important to note that 5 of these vignettes involved an old, sick patient, whereas one involved a young, healthy patient with a 2-part varus fracture. Additionally, there was a downward trend in the percentage favoring nonoperative treatment with increasing complexity of the fractures. This reflects the current thoughts that patients with minimally displaced fractures and elderly patients do well with nonoperative treatment.[9,10,18,20]

Part of the difficulty in interpreting the literature on PHFs is the vast heterogeneity of patient- and fracture-specific features (age, comorbidities, function, bone quality, fracture pattern). Furthermore, there is an incredible amount of variance in the quality and characteristics of research articles on PHF outcomes and management.[24] A systematic review by Richard et al[24] found that 22 different outcome measures were used in 74 articles evaluating PHFs. Although the Neer classification system has become the most commonly used system, there has been question of its reliability and reproducibility.[14,27] It is of concern, as well, that some papers using a classification system as part of its methods may not include sample radiographs in their manuscripts. This underscores the challenges of interpreting the current data because of constraints on cross-study analyses.

There is also variability in the inclusion criteria and treatments rendered, both of which have a substantial impact on the ultimate results. Furthermore, the question could be whether these results are clinically applicable. Some studies identified only patients hospitalized with a PHF, thus missing any patients who presented in an outpatient setting.[7,9,11,14,17,18,22]

This patient sample may not, in fact, be wholly representative of the PHF population, as patients who are hospitalized tend to have more comorbidities or more acute injuries.[6] A meta-analysis by Sabharwal et al[26] demonstrated outcome differences when interpreting data based on fracture pattern and surgical treatment compared to when all types were grouped together. Not only does this cause us to give pause when reviewing the current literature, it also demonstrates the need for more specific trials based on fracture pattern and/or surgical treatment.

Given the above challenges in addition to the ethical concerns with truly randomized control trials in this setting, the aim of this study was to gain insight into the preferred management of PHFs by a pristine group of experienced shoulder experts that constitute the Neer Circle. Confronted with a specific patient profile with various fracture patterns, we sought to identify the areas where there was consensus among the experts and also where no consensus could be reached. This study is by no means supposed to dictate management; instead, it is to highlight the areas of ambiguity in order to help direct future research efforts.

There was good consensus on the value of CT scans with 3D reconstructions, particularly for the use of preoperative planning in surgical cases. Age was an important factor in determining treatment, as 5 of the 7 operative cases were in young, healthy patients. Where age would not influence decision making was in the setting of a dislocation. No matter the age, it was agreed on that dislocations should be treated surgically. In addition to age, there was agreement that functional demand, fracture pattern, bone quality, and the presence of more significant medical comorbidities would strongly affect decision making. Experts agreed that medial calcar involvement would have no impact on their decision, and gender and nondominant arm involvement would have a low impact.

There was also good consensus on the role of RSA for elderly patients with fracture dislocations of the proximal humerus. Not as clear is the optimal management of 3-part fractures, particularly in the young, healthy patient. Although there was agreement to avoid arthroplasty, there was no consensus reached on the specific operative treatment method. Optimal management could not be agreed on for a 2-part varus fracture in a young healthy patient and for an older, unhealthy patient with either a 2-part shaft fracture, 3-part varus fracture, 3-part valgus fracture, 4-part fracture, or 4-part valgus impacted fracture. Finally, there was no consensus on preferred rehabilitation protocols, whether for nonoperative management or postoperative care.

The presented study has several limitations. The first is associated with the inherent limitations of a survey study. Throughout the duration of the study, there was an appropriate response rate. Second, only 2 patient types were considered in the vignettes, and only radiographs were provided for decision making. Although this may seem overly simplistic, the goal was to focus on 2 broad cohorts in order to minimize survey fatigue and to also serve as a springboard for future studies. The third limitation was that the survey was sent to only the members of the Neer group and, therefore, is not representative of the entire ASES organization. This group of experts, however, undoubtedly have the patient volume and experience to strengthen the credibility of the results. A major strength of the study was that members of the Neer Circle carefully reviewed numerous radiographs to come to a consensus on what constitutes each fracture pattern. They also agreed on the patient factors to be considered and the representative radiographs, thus ensuring conformity among the respondents.

Conclusion

This study demonstrates that consensus when managing PHFs is limited to specific scenarios, although confusion still exists in others. The standardized approach to this study helps eliminate the pitfalls that have plagued studies to date, such as selection bias. This study serves as a strong starting point from which further investigation can occur, particularly in regard to management of

PHFs in the sicker patient and ideal surgical treatment methods for 3-part and 4-part fractures in the young, healthy patient.

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Supplementary Data

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