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Acromioclavicular joint injuries: multicenter expert consensus study using the Delphi method

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Background: Acromioclavicular (AC) joint injuries pose significant challenges in clinical management, necessitating consensus guidelines for optimal treatment. There is a lack of consensus in several areas, including imaging protocols, surgical techniques, and rehabilitation timelines. This study aims to develop a consensus regarding the diagnosis, treatment, and rehabilitation of AC joint separations.
Methods: Using the Delphi method to gather expert opinions, 18 fellowship-trained surgeons from the American Shoulder and Elbow Surgeons participated in 3 survey rounds, achieving a 100% response rate over each round.
Results: A total of 76 consensus statements were identified in 6 areas: history, physical examination, radiology, treatment, surgical technique, and rehabilitation. Consensus was reached on some of the fundamental principles of AC separation management, such as the importance of a comprehensive history and physical examination, multiple radiographic views of the joint, indications for surgery, and the usefulness of allograft tendon augmentation for repair of the joint when surgery is indicated.
Conclusion: The Delphi method proved effective in gathering diverse perspectives and quantifying consensus among experts, offering important insights into the management of AC joint injuries. Continued research efforts are warranted to address areas of controversy and establish improved guidelines for the diagnosis and treatment of these injuries.
Level of evidence: Level IV; Consensus Study; Delphi Method

Keywords: Shoulder; acromioclavicular joint; consensus; Delphi; diagnosis; treatment

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Acromioclavicular (AC) joint separations are common shoulder injuries that can lead to loss of strength and function in the shoulder, impingement syndromes, and even neurovascular complications.[20] These injuries can affect individuals across a wide age range and activity level. The incidence of AC separations is as high as 2 per 10,000 people per year,[29] constituting up to 9% of all shoulder injuries.[7] Typically, male patients face a higher risk of AC joint injuries than their female counterparts, and athletes, regardless of gender, have a significantly elevated risk.[31] Notably, contact sports such as ice hockey, lacrosse, and football exhibit a much higher incidence of AC joint injuries when compared to the general population.[1,8,9,18]

The standard mechanism of injury typically involves a direct blow to the lateral aspect of the acromion process with the shoulder in an adducted position. This impact can push the acromion inferiorly while leaving the clavicle in its normal anatomical position, resulting in injury to the AC and coracoclavicular (CC) ligaments. While low-grade injuries may only involve a sprain to the AC ligament, more severe injuries can also involve the CC ligaments causing displacement of the shoulder girdle, and there can be disruption of the insertions of the deltoid and trapezius muscles onto the clavicle.[24] AC joint injuries are usually graded using the Rockwood Classification, with low-grade injuries being classified as Types I through III, and high-grade injuries classified as Types IV through VI.

Treatment options may range from nonoperative management, such as immobilization with a sling followed by physical therapy,[37,40,43] to surgical intervention.[15,39,42] There are numerous surgical approaches, and there is limited evidence that any 1 technique consistently yields better results than others.[12] While the use of CC screws to fixate the distal clavicle has fallen out of favor due to hardware failures and the need for screw removal,[24] hook plates, coracoacromial ligament transfer (Weaver-Dunn), anatomic CC reconstruction, and arthroscopic-assisted techniques have all demonstrated excellent clinical outcomes.[5]

A lack of consensus exists regarding optimal evaluation and management for these injuries, including best practice methods to initially assess these injuries in the office, which injuries require surgery, surgical technique to use, and even how to appropriately rehabilitate the patient after surgery.[32] The primary objective of this study is to use the Delphi method, a systematic approach for gathering expert opinions, to establish consensus guidelines for the evaluation and management of AC joint separations.

Materials and methods

An expert panel was assembled, consisting of 18 members from the American Shoulder and Elbow Surgeons (ASES) multicenter group studying AC joint injuries. Each panel member is a fellowship-trained, board-certified orthopedic surgeon and an ASES member. The panel was self-selected, as participation was on a volunteer basis, with invitations sent to ASES members interested in contributing to multicenter research on AC joint injuries. Institutional review board approval was waived as no patient specific data were used.

A working group crafted the initial statements based on input from the larger panel. The Delphi method was used to establish a group consensus on the statements generated by the working group. The statements were organized into 6 groups including history, physical examination, radiology, treatment, technique, and rehabilitation. Online surveys were distributed to all 18 experts, who used a Likert[26] scale with 5 possible responses: strongly agree, agree, neutral, disagree, and strongly disagree. A numerical value of 5 (strongly agree) to 1 (strongly disagree) was assigned depending on the answer. A pilot phase ensured face validity, understanding, and acceptability. Minor modifications were implemented based on pilot feedback and then the survey was distributed to the group.

Between rounds, analysis was performed of the collected responses and suggestions for the preparation of amended statements added to the next round. For example, in the first round, statement 41 read: "Acute Type III AC joint injuries should undergo initial nonoperative treatment." In the open-ended response section, several respondents suggested differentiating between Type IIIA and IIIB injuries in the following survey, which was promptly implemented in the second round. Consensus was defined as 80% agreement and $<$ 10% disagreement. The iterative process continued until a consensus was reached or for a maximum of 3 rounds. Details of the consensus process are presented in Figure 1. Data analysis was performed using Research Electronic Data Capture.

Results

Eighteen fellowship-trained shoulder surgeons from the ASES completed the first-round survey. The working group generated 74 items from discussions and a literature review for consideration by the expert panel in the first-round survey. These items were categorized under 6 headings: history, physical examination, radiology, treatment, technique, and rehabilitation.

All 18 respondents participated in both rounds 2 and 3 of the study as well, achieving 100% participation. The results of each survey round are summarized in Table I, and the levels of agreement in rounds 1 to 3 are presented in Figures 2-4, respectively.

Of the 74 items, 46 (62.2%) achieved consensus in the first round and were subsequently removed from the pool of items for the second survey. In the second round, 60 new questions were added, bringing the total number of questions in the second survey to 88. Nineteen items (21.6%) of these 88 items reached consensus and were removed from the pool for the third survey. In the third and final round, 29 new questions were added, bringing the total number of questions to 98. Eleven (11.2%) of these 98 items reached a consensus. Overall, consensus was reached on 76 (29.2%) of the 260 items, with more than 80% agreement among experts and less than 10% disagreement (Supplementary Table A4). Supplementary Tables A1 through A3

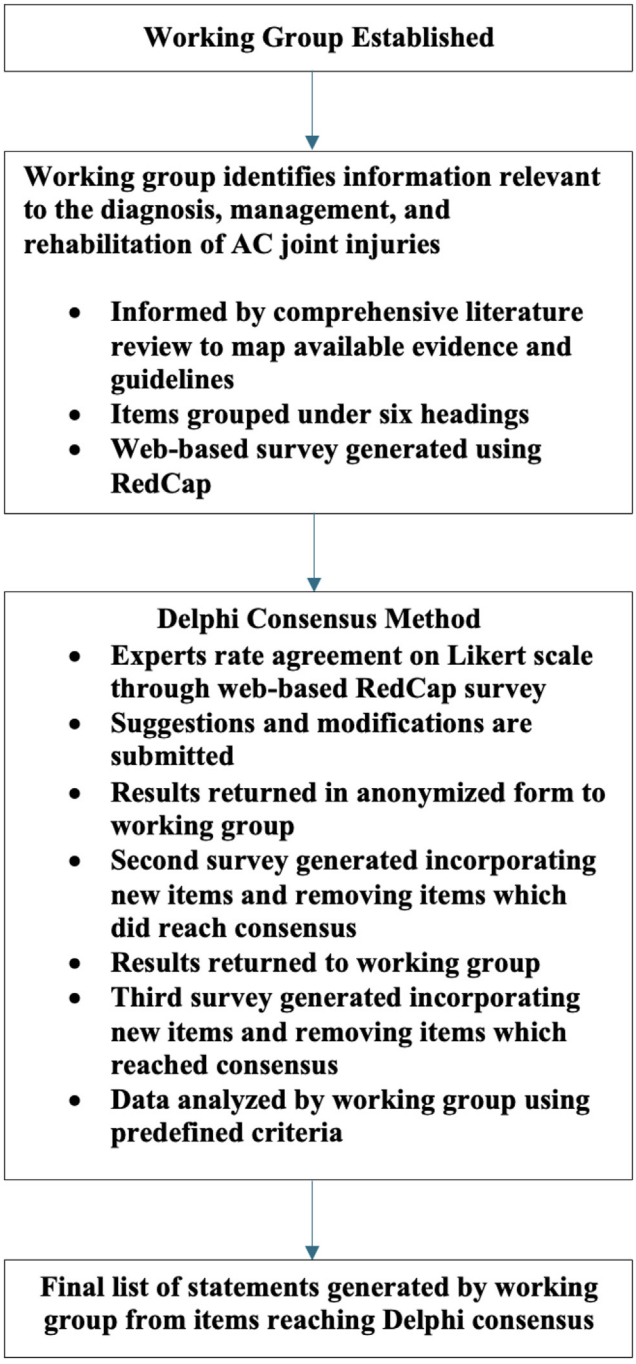

Figure 1 Flowchart showing the consensus process. *AC*, acromioclavicular.

summarize the items in each round of the consensus process, while Supplementary Table A4 lists all items that reached consensus in 1 of the 3 rounds.

(A) **History.** A thorough and comprehensive history and mechanism of injury are paramount to making an accurate diagnosis of an AC joint injury. All respondents agreed that the patient history should include the degree of pain, weakness, and instability and the functional demands and goals of the patient. It was agreed upon that an acute injury is defined as occurring within 2 weeks while a subacute injury is one that has been present for 2 to 6 weeks. Consensus was not reached on what length of time defines a chronic AC joint injury. Other areas of consensus included the patient's perception of the importance of cosmesis, hand dominance, occupation, recreation, smoking status, and mechanism of injury.

(B) **Physical examination.** Areas of consensus within the physical examination section included assessing the degree of prominence of the distal clavicle in the superior and anterior/posterior directions in relation to the acromion, assessing tenderness to palpation of the distal clavicle, determining the degree of horizontal instability using either the cross-arm test or anterior drawer test, assessing vertical instability with the shuck test, and evaluating scapular motion. Respondents also agreed that assessing shoulder weakness and range of motion are important aspects of the physical examination. Finally, it was agreed that it is not always possible to determine type IIIA versus IIIB injuries from the physical examination alone.

(C) **Radiology.** Radiographs were agreed to be the standard initial imaging modality used to evaluate AC joint pathology; however, survey responses highlighted the importance of having multiple views of the AC joint, with consensus being reached for imaging to include anteroposterior, Grashey, axillary, and Zanca radiographs. It was also agreed upon that imaging should include both the injured and contralateral shoulder radiographs. Our survey reached a consensus that magnetic resonance imaging (MRI) should not be included in standard evaluation of acute injuries, but that it may be used in the setting of concerning physical examination findings or chronic AC joint injury. There was also near-unanimous agreement that imaging should not standardly include computerized tomography scans for evaluation. Respondents unanimously agreed on not needing weighted radiographs and agreed that it was not possible to determine IIIA versus IIIB injuries solely based on radiographs.

(D) **Treatment.** Respondents agreed that superior/inferior and anterior/posterior displacement are both important factors in determining operative versus nonoperative treatment as well as patient age, hand dominance, and time since the original injury. The participants also agreed that a concomitant rotator cuff tear is an important factor in determining operative versus nonoperative treatment. The Delphi process produced agreement that patient occupation is an important factor in determining operative versus nonoperative treatment. Likewise, there was agreement that Type I and II injuries should be managed nonoperatively, whereas Type IV-VI injuries typically warrant operative intervention. Type III injuries generally proved to be the most controversial with regards to management.

Table I Summary of results at the completion of each survey round in the Delphi process to establish a consensus regarding acromioclavicular joint injuries

Delphi round	Response rate, %	Total items included in survey	Items reaching consensus,* %	New items or modifications suggested
1	100	74	62.2	60
2	100	88	21.6	29
3	100	98	11.2	5

* In round 1 of the survey, items were retained for round 2 if $\geq$ 70% of the respondents agreed on their inclusion and $<$ 20% disagreed. Statements not meeting these criteria were discarded or modified per the responders' suggestions. In round 2, the items were retained for round 3 if $\geq$ 70% of respondents agreed and $<$ 10% disagreed. In round 3, items were considered as reaching a consensus if $\geq$ 80% of the respondents agreed and $<$ 10% disagreed.

The cohort agreed that acute Type IIIA injuries should undergo initial nonoperative treatment, but Type III injuries that fail initial nonoperative treatment should be offered surgery. Additionally, it was agreed that patients can be considered to have failed conservative treatment after 3 months.

(E) **Surgical technique.** The Delphi method produced an agreement that surgical treatment of subacute and chronic AC instability should have tendon augmentation with allograft while the group did not reach consensus regarding the use of autograft tissue. They also agreed that surgery could be performed either open or arthroscopic-assisted and that a technique with 2 drill holes in the clavicle is one acceptable construct option. The participants also agreed that having no clavicle drill holes would also be an acceptable construct. Consensus was reached that reconstruction techniques should additionally incorporate suture or nonbiological material, even when using allograft or autograft. Furthermore, the group agreed that allograft tissue is acceptable in all cases when biological augmentation is employed. Finally, it was agreed that graft pretensioning should be performed when using autograft or allograft biological augmentation and if tissue quality permits, repair of the AC joint capsule should be performed. The use of hook plates or Weaver Dunn constructs for initial surgical treatment of AC joint injuries without bone loss showed controversy, with most respondents agreeing that these were not acceptable constructs. In general, respondents disagreed with the statement that distal clavicle resection should be routinely performed during surgical treatment. Additionally, there was a preference for arthroscopic-assisted techniques over purely arthroscopic techniques.

(F) **Rehabilitation.** Points that did reach consensus include immobilization for at least 6 weeks postoperatively from AC joint reconstruction, weight-bearing and resistance training for the operative shoulder should begin 3 months following surgery, and the typical timeline for return to sport is at least 6 months. It was also agreed upon that rehabilitation timelines should vary depending on surgical technique. Respondents disagreed that the rehabilitation timeline should vary based on preoperative degree of displacement.

Discussion

This study seeks to apply the scientific Delphi method to reach consensus on issues surrounding AC joint evaluation and management. Given the lack of a clear standardized algorithm for approaching the treatment of AC joint injuries, it is important to integrate multiple perspectives from various experts in the field of shoulder surgery. Achieving consensus among experts is important for several reasons. Standardized treatment guidelines can lead to improved patient outcomes, reduced variability in clinical practice, and enhanced overall care for individuals suffering from AC joint separations.[22] Additionally, such guidelines can serve as a valuable resource for healthcare providers, facilitating informed decision-making and optimizing patient care.

The multicenter nature of this study included expert opinions from diverse geographic locations within the United States. Online asynchronous methods have proven as reliable as face-to-face panels while offering convenience for the participants.[46] Moreover, it ensures equal weighting of each participant's input and minimizes the potential for bias from group dynamics. Finally, this method quantifies the requirements for reaching consensus. However, weaknesses of the Delphi method include potential loss to follow-up, especially in studies with multiple survey rounds, and limited opportunities for open discussion. The 100% response rate achieved across all 3 rounds in this study underscores our cohort's commitment to the study's goals and process.

Additionally, the online Delphi method eliminates the need for logistically inconvenient face-to-face meetings, providing experts with the time and privacy to carefully consider aggregated feedback before responding to subsequent questionnaires. Disadvantages of the Delphi

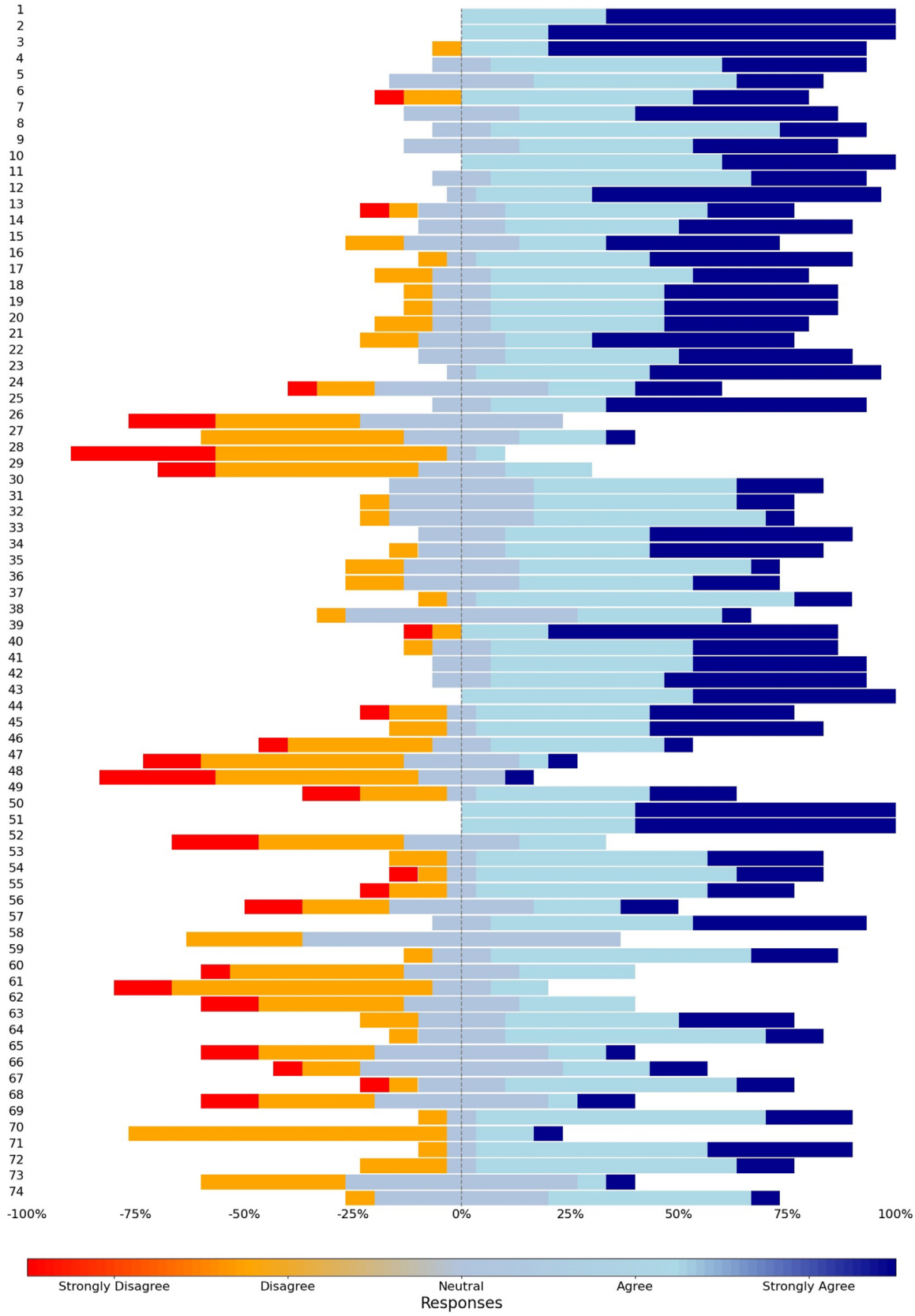

Figure 2 Levels of agreement for statements included within the first-round survey. Full statements and values are available in Supplementary Table A1.

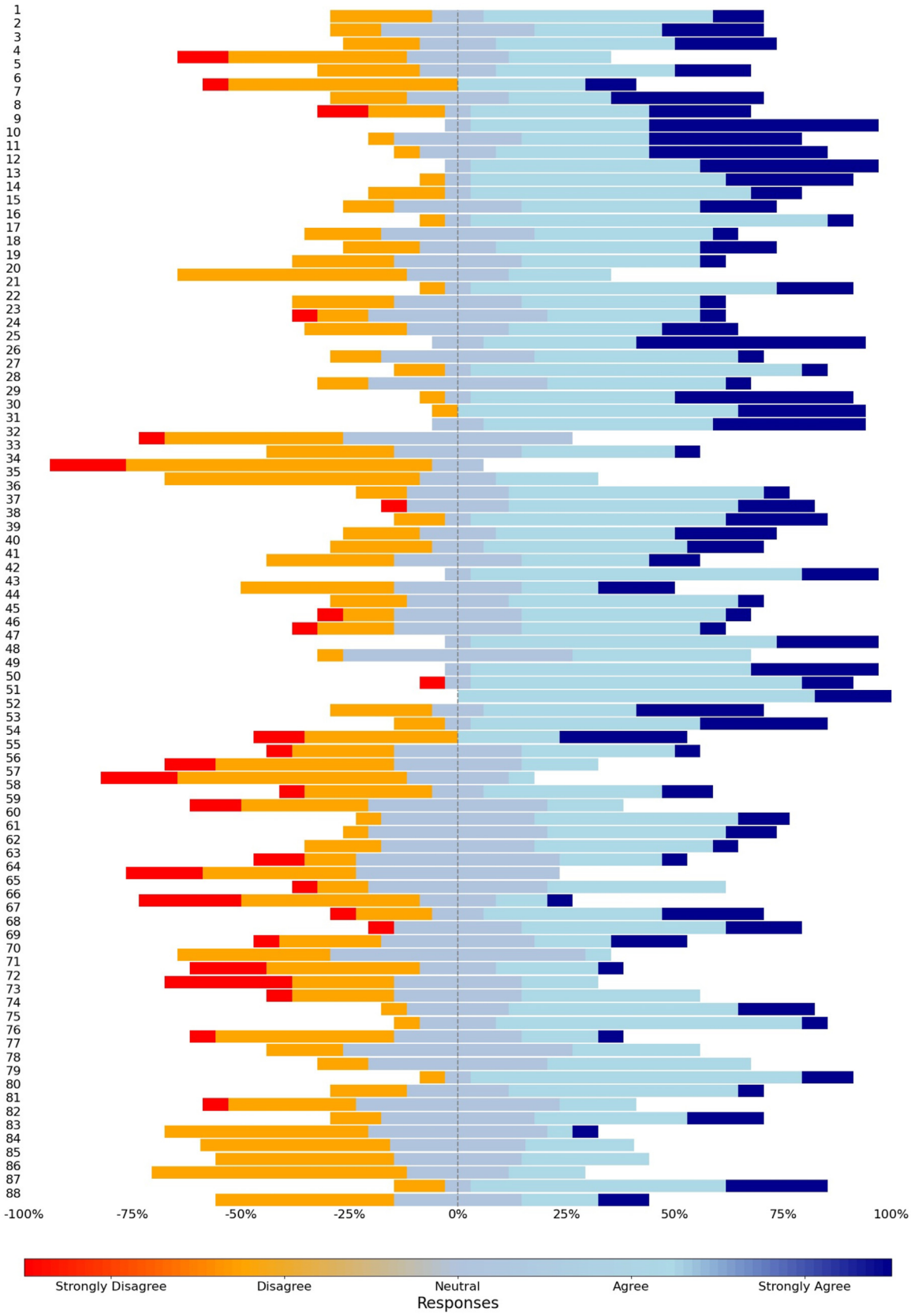

Figure 3 Levels of agreement for statements included within the second-round survey. Full statements and values are available in Supplementary Table A2.

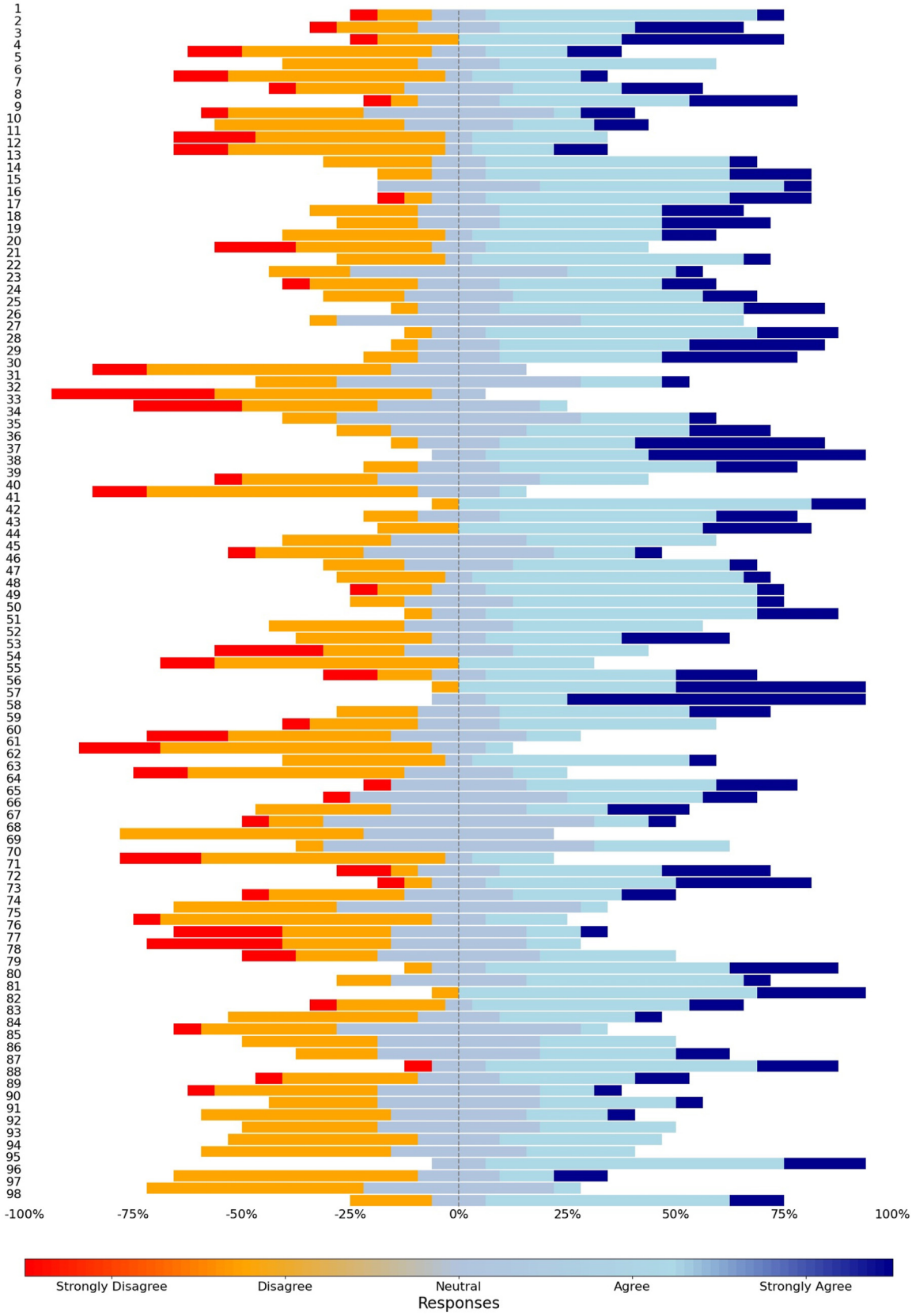

Figure 4 Levels of agreement for statements included within the third-round (final) survey. Full statements and values are available in Supplementary Table A3.

technique, such as dropouts and facilitator bias,[4] can be minimized by restricting the total number of iterations, ensuring brief questionnaires, and allowing expert panel members to contribute their own questions.[3,19,33]

The relevant findings in this study in terms of patient history were that pain, occupation, recreation, functional goals, and smoking status were all considered relevant aspects to care. Interestingly, consensus could not be reached in defining the full timeline for injury chronicity. Acute injures were agreed to be within 2 weeks, and subacute injuries within 2 to 6 weeks; however, there was no consensus on whether 6 weeks or 12 weeks was considered a chronic injury. Similarly, a patient's age was considered to be an important factor in the patient history by 88% of respondents but did not reach consensus due to 11.8% who disagreed. The discordance in defining chronicity of AC joint injuries becomes less significant when considered alongside our other findings. Traditionally, time since injury has been an important parameter because tendon grafts were used for chronic cases but not acute injuries. However, our experts recommend the use of graft material for CC reconstruction in all cases regardless of chronicity. Consensus was also reached that the AC joint capsule should be repaired during CC ligament reconstruction, through open visualization if needed. This consensus on use of allograft reduces the importance of distinguishing between acute and chronic injuries, as its role in surgical decision-making would be decreased. Interestingly, the panel favored allograft over autograft for augmentation. Conflicting evidence exists regarding graft material selection, with a lack of high-level studies comparing autograft and allograft in large sample sizes. A recent systematic review reported higher reoperation for allograft reconstructions but an increased risk of loss of reduction with autograft reconstructions.[34] The increased loss of reduction risk, along with greater availability, reduced donor-site morbidity, and comparable outcomes, likely influenced our experts' preference for allograft reconstruction.

The most widely used classification system for AC joint separations is the Rockwood Classification, which categorizes these injuries into 6 types.[14,38,42] The Upper Extremity Committee of the International Society of Arthroscopy, Knee Surgery and Orthopedic Sports Medicine proposed a subclassification of Rockwood Type III dislocations into stable (Type IIIA) and unstable (Type IIIB) variants based on the degree of displacement.[21] However, this approach relies on subjective surgeon judgment during re-examination to assess scapular dyskinesis,[10] which can introduce inconsistencies in classification and complicate the determination of optimal treatment strategies. Classifying AC joint injuries can be challenging, especially when evaluating horizontal displacement of the acromion on standard radiographs.[13] In general, the use of additional imaging, such as cross-body or Basamania radiographs, MRI, and 3-dimensional reconstruction from computerized tomography imaging, has been proposed to provide more accurate assessments of associated injuries and displacement of AC joint injuries.

Imaging plays a crucial role in diagnosing and grading AC joint injuries following a comprehensive history and physical examination. Despite its importance, there is no standardized protocol for imaging acute AC joint separations.[35] Single anteroposterior radiographs can be inadequate for evaluating the AC joint due to variations in projection and lack of consistent measurement.[45] Grashey or Zanca views were preferred in this study to visualize the AC joint and distal clavicle.[47] Additional views, such as axillary and lateral radiographs, were also regarded as helpful. Regarding imaging for horizontal instability, cross-body adduction radiograph was included in the questions but did not reach consensus in the final dataset. Consensus in this study highlights the importance of multiple radiographic views and bilateral imaging, providing a reference for the patient's usual articular configuration, AC, and CC distances.[41] An MRI was deemed valuable only in cases with concerning physical examination findings for associated injuries and in chronic AC joint separations, which is supported by other literature as well.[44]

Consensus in this study regarding treatment of low-grade AC joint injuries favored nonoperative management, focusing on immobilization and anti-inflammatory medications followed by targeted rehabilitation.[36] In contrast, surgery was favored for high-grade AC joint injuries, which also aligns with published literature.[17] This study also supported consensus statements that a trial of nonoperative management was appropriate even for high-grade injuries, and surgery could be offered if conservative management was not satisfactory. Patients can be considered to have failed conservative treatment after 3 months, according to this study. A rare presentation of AC joint injury is that of a locked superior dislocation, which commonly requires surgical intervention.[11] This specific type of injury was not included in the survey due to its rarity and the existing consensus that surgical management is necessary for such cases.

When surgery is indicated for AC joint injuries, various techniques can be employed.[2] Two tunnel technique with allograft and AC joint capsule repair was the group consensus procedure for surgical treatment, although other techniques were considered viable as well, such as a no-tunnel technique with graft around the clavicle and arthroscopic-assisted procedures. The group generally agreed that hook plates should not be recommended as a primary method of fixation for AC joint injuries, likely due to the need for a second operation to remove the plate and concerns about potential complications.[20] However, 30% of the panel felt that in selected cases, hook plates could be an acceptable option. Some of

the discordance may stem from the wording of the statement, and studies have shown that hook plate fixation can achieve good clinical results in certain cases.[23,27] This variation in opinions highlights the importance of individualized surgical decision-making. The Weaver-Dunn procedure was also generally not favored as a primary reconstruction option, but some experts noted that it could be acceptable in certain cases.

Similarly, standardized rehabilitation guidelines following CC ligament reconstruction remain elusive. While individualized rehabilitation plans are essential,[25] a lack of consensus may lead to confusion and prolonged recovery times for patients.[6] Areas of agreement in the rehabilitation section were that a sling was necessary for 6 weeks postoperatively from AC joint reconstruction, weight-bearing and resistance training could begin 3 months following surgery, and that the typical timeline for return to sport is at least 6 months.

Our study has some limitations. While the Delphi method allows for a more scientific approach to consensus-building than other techniques,[16] it is not free from the risk of bias. However, the anonymity of responses in the Delphi process is crucial for minimizing these biases that may be present in other methods of achieving group consensus, and in preventing dominant personalities from unduly influencing the opinions of other experts in the group.[30] Additionally, the medium-sized cohort may increase the influence of individual participants. However, it is important to note that as few as 10 experts are considered adequate for content validation and was achieved by our study of 18 experts.[28] Medium sample size combined with a high threshold for consensus made it more likely that certain statements with relatively high amounts of agreement were not considered to have achieved consensus. While setting a high threshold for consensus in this study meant that fewer statements were able to reach consensus, the statements that did reach consensus represented a vigorous response with a high degree of concordant views. Another potential limitation is the composition of the expert panel surveyed. Although the panel consisted of a well-rounded group of fellowship-trained shoulder and elbow surgeons, there was an absence of strong proponents for certain techniques, such as hook plate fixation. Future studies may benefit from including experts with varying preferences for less commonly used techniques to ensure that all viable options are fully explored. With these limitations in mind, we offer this information as a resource to clinicians, who should also consider clinical factors, social contexts, and patient preferences to guide treatment decisions. This information is not intended to set a standard of care, dictate surgical indications, or influence reimbursement decisions.

This study identified potential areas for future research, such as the role of biologic augmentation in AC joint surgery. The consensus in our study was that allograft augmentation is necessary in CC ligament reconstruction, with allograft being largely preferred by our experts over autograft. However, further research is warranted. Finally, understanding whether injury chronicity is relevant merits additional research.

In summary, this study identified several key areas of consensus using the scientific Delphi method to evaluate the diagnosis and management of AC joint injuries.

Conclusion

Our study has established an expert consensus on 76 statements relating to the diagnosis, treatment, and rehabilitation of AC joint injuries. Continued efforts are warranted to find areas of agreement and explore relevant areas for future research in the management of these injuries.

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Supplementary data

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