Subacromial Decompression in Patients With Shoulder Impingement With an Intact Rotator Cuff: An Expert Consensus Statement Using the Modified Delphi Technique Comparing North American to European Shoulder Surgeons

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Purpose: To perform a Delphi consensus for the treatment of patients with shoulder impingement with intact rotator cuff tendons, comparing North American with European shoulder surgeon preferences. **Methods:** Nineteen surgeons from North America (North American panel [NAP]) and 18 surgeons from Europe (European panel [EP]) agreed to participate and answered 10 open-ended questions in rounds 1 and 2. The results of the first 2 rounds were used to develop a Likert-style questionnaire for round 3. If agreement at round 3 was $\leq$60% for an item, the results were carried forward into round 4. For round 4, the panel members outside consensus (>60%, <80%) were contacted and asked to review their response. The level of agreement and consensus was defined as 80%. **Results:** There was agreement on the following items: impingement is a clinical diagnosis; a combination of clinical tests should be used; other pain generators must be excluded; radiographs must be part of the workup; magnetic resonance imaging is helpful; the first line of treatment should always be physiotherapy; a corticosteroid injection is helpful in reducing symptoms; indication for surgery is failure of nonoperative treatment for a minimum of 6 months. The NAP was likely to routinely prescribe nonsteroidal anti-inflammatory drugs (NAP 89%; EP 35%) and consider steroids for impingement (NAP 89%; EP 65%). **Conclusions:** Consensus was achieved for 16 of the 71 Likert items: impingement is a clinical diagnosis and a combination of clinical tests should be used. The first line of treatment should always be physiotherapy, and a corticosteroid injection can be helpful in reducing symptoms. The indication for surgery is failure of no-operative treatment for a minimum of 6 months. The panel also agreed that subacromial decompression is a good choice for shoulder impingement if there is evidence of mechanical impingement with pain not responding to nonsurgical measures. **Level of Evidence:** Level V, expert opinion.

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Nearly 50 years ago, Neer first published his landmark article introducing open anterior acromioplasty for the treatment of symptomatic shoulder impingement.[1] Fifteen years later, Ellman[2] introduced the concept of arthroscopic subacromial decompression (SAD) and reported excellent and good outcomes in 90% in a consecutive case series of 50 patients 1 to 3 years after surgery. Since these original descriptions by Neer and Ellman, SAD has become a widely accepted surgical technique with consistently good and reliable outcomes.[3-8]

The original indications for surgery in the Ellman series were patients with chronic impingement syndrome who had not responded to prolonged conservative management.[2] More explicit indications also have been outlined by a recent clinical practice guideline suggesting SAD should be considered if and when symptoms last for at least 6 months; night pain is a prominent component; there is a persistently positive Hawkins test; pain persists despite physical therapy for at least 6 weeks; and complaints fail to respond to a short course of anti-inflammatory medication. Furthermore, there should be radiologic evidence of mechanical impingent with sclerosis, cysts, or osteophytes at the greater tuberosity and acromion, anterior acromial spurs visible on plain radiographs, and no evidence of a high degree or complete rotator cuff tear on magnetic resonance imaging (MRI).[3]

However, the procedure remains highly controversial, and there is considerable discussion as to whether SAD should still be performed.[9-13] Continuation of this practice has been discouraged by 3 recent meta-analyses,[14-16] which concluded that surgical intervention has little benefit, with only small improvements regarding pain and function. However, these authors also admitted that the evidence is of low and moderate quality with moderate-to-high risk of bias and noted that further research is required to identify patients who will reliably benefit from surgical intervention.[14,15]

The Delphi method allows survey research of experts in the field in a high-quality and scientific manner, and may provide more direct answers to a clinical question where evidence-based medicine cannot provide a clear guideline for a specific topic or is limited by biases, poor study quality, or the inability to reach valid conclusions.[17-19]

Therefore, the purpose of this study was to perform a Delphi consensus for the treatment of patients with shoulder impingement with intact rotator cuff tendons, comparing North American with European shoulder surgeon preferences. It was hypothesized that consensus with regards to surgical indications would not be reached, but that the European and North American approach with regards to diagnosis and treatment would be similar.

Methods

The Delphi panel technique was used as previously described.[18] The principle of Delphi includes definition of the problem, panel selection, question development, open questions for round 1, feedback between rounds, and further rounds until either consensus or an impasse is reached.[18] A 4-round approach was planned in this study; however, if agreement after round 3 for a specific item was 60% or less, consensus would have been

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unlikely with a further round and the results of round 3 were carried forward into round 4. Similarly, if consensus was reached for an item, the results were also carried forward into round 4. If consensus was more than 70% and less than 80% panel members who were outside consensus were asked to reconsider their decision. This approach was used as SAD remains a highly controversial topic with unclear evidence, and most experts and colleagues are likely to have a strong opinion unlikely to be swayed.

For this project, arthroscopic SAD surgery was specifically limited to patients with shoulder impingement pain with an intact rotator cuff and no other associated conditions, such as long head biceps tendon pathology, calcific tendinitis, and secondary impingement due to laxity. Nevertheless, the opinion of the panel for these variables also was explored (Tables 1-5). The level of agreement for consensus was defined based on previous recommendations as 80% to reduce selection bias and achieve valid results.[20,21]

Question Development

The steering group consisted of 4 experienced clinicians and researchers (E.H., K.T., K.S., V.G.). Two of the steering members were experienced shoulder surgeons with surgical experience exceeding 20 years. For question development the clinical guideline published in Arthroscopy was used, and the current controversies highlighted in the guideline were identified.[18] In addition, a literature review was performed on Medline, Embase, Scopus, and Google Scholar using the following Boolean terms: "subacromial decompression" AND/OR "shoulder impingement" AND/OR "shoulder arthroscopy"; "bursectomy." Articles were also manually cross-referenced to ensure that all potential studies were included. The search was limited from 1971 to 2021, and restricted to patients aged at least 18 years with no upper age limit. Based on this review of the clinical guideline and the published literature, the first round of open questions was developed (Table 1).

Panel Selection

The current recommendations for the panel of experts recommends a mix of nonacademic and academic practitioners with an initial panel list between 15 and 35 experts.[18,22] To select suitable experts abstracts of the 2015-2019 AANA (Arthroscopy Association of North America) and European Society of Sports Traumatology, Knee Surgery and Arthroscopy annual scientific meetings were screened. In addition, the abstracts of the *Journal of Arthroscopy*, *American Journal of Sports Medicine*, *Knee Surgery Sports Traumatology Arthroscopy*, and *Journal of Shoulder and Elbow Surgery* was searched for colleagues who had previously published on this topic. The senior authors were then invited to participate as panel members. The steering committee (E.H., K.T., K.S., V.G.) then compiled an initial list of 20 North American and 20 European shoulder surgeons. Of the 20 North American surgeons, one surgeon was not approached because of acute illness from coronavirus disease 2019 (COVID-19), but the other 19 responded and agreed to participate in the project. Of the 20 European surgeons who were approached, one surgeon declined the invitation, as his practice had a strong focus on shoulder arthroplasty, and one surgeon declined due to COVID-19 illness, with the other 18 surgeons from Europe agreeing to participate.

Rounds 1 and 2

In round 1, the 11 open questions were electronically delivered to the panel. They were asked to answer the questions in a narrative fashion and argue their case as specifically as possible, using recently published literature if required. The results of round 1 were summarized and the chair of the steering committee highlighted controversies and agreements from the first-round responses. Based on these responses, 14 open and semi-open-ended questions were developed and again delivered to the panel via email for round 2 (Table 2).

Rounds 3 and 4

Based on the responses from round 1 and 2, controversies and potential agreements were analyzed, and a summary was emailed to the panel members. Likert-style questions were then developed for round 3 (Table 3). Similar to a previous Delphi study,[19] the questions were grouped under subheadings to facilitate easier answering. As explained earlier, a final round 4 was only performed for items in which the agreement was between 70% and 80%. Panel members who were outside the "majority" were contacted and asked to reassess their responses, and then re-rank their agreement for each item. The level of agreement was defined as a minimum level of 80%.[18,19]

Statistical Analysis

The results of rounds 3 and 4 were described as calculated percentiles. Consensus was defined if a minimal level of agreement of 80% was achieved. If there was consensus against a specific item, the results were reported as consensus to disagree.

Results

All 37 panel members completed the first 3 rounds. Of the 18 European shoulder surgeons, 6 were academic and university-based, 2 were academic and university-based but also treated community patients, 8 were community-based but had academic affiliations, and 2 surgeons were community-based. Of the 19 North American shoulder surgeons, 12 were academic and

university-based, one was academic and university-based but also treated community patients, 4 were community-based but had academic affiliations, and 2 surgeons were community-based. All panel members were fellowship-trained in Orthopaedic Sports Medicine.

Round 1

The responses for the first round indicated that impingement is a clinical diagnosis presenting with anterolateral pain, pain with overhead movements and with resisted forward flexion, and the presence of night pain. Radiographs are required to exclude other contributing conditions such as osteoarthritis, calcific tendinitis, rotator cuff arthropathy, and acromial morphology. The first-line treatment should be physical therapy, and failure of nonoperative treatment is a potential indication for surgery. There was consensus that corticosteroid injections can be helpful, but there was no agreement as to the timing, frequency, or whether they can be considered as a diagnostic tool. The panel did not offer an opinion as to who would benefit from surgery, but agree that patients that are noncompliant with physical therapy, patients with depression and anxiety disorders, and patients on workers compensation would be expected to have inferior outcomes.

Round 2

In round 2, the need for radiographs was further explored, and one-third of the panel would wait for 6 weeks and only request radiographs if patients do not respond to treatment. There was no agreement whether there is a role for MRI. Approximately 50% of the panel would order MRI on initial presentation, but the panel also reported that the many of their patients would present with an MRI from an outside institution. The timing of steroids was controversial, and only 50% would inject before physical therapy. Most surgeons would limit the number of injections to a maximum of 3, but there was general reluctance to repeat steroid injections. In total, 50% of the panel would offer surgery to patients who underwent 6 months of nonoperative treatment with sufficient physical therapy, a course of nonsteroidal anti-inflammatory drugs (NSAIDs), and persistent positive impingement signs (Jobe, Neer, and Hawkins–Kennedy); 4 surgeons would not offer SAD to any of their patients. Chronic pain, young overhead athletes, patients with social issues, cervical spine pathology, patients on workers compensation, scapular dyskinesia, frozen shoulder, shoulder stiffness, pain unresponsive to injections, and those medically unfit were all considered unsuitable for SAD.

Round 3

Of the 71 Likert-style items, agreement was reached for 16 selections and near agreement (between 75% and 80%) for another 2 items when pooling the North American and European panels (Table 3). The North American panel (NAP) reached consensus for 22 items (Table 4). The European panel (EP) reached agreement for 16 items and near agreement for 4 (Table 5). Both the NAP and EP agreed that impingement is a clinical diagnosis; a combination of clinical tests should be used; other pain generators such as calcific tendinitis, long head biceps pathology, rotator cuff tears, and acromioclavicular joint osteoarthritis must be absent for the diagnosis of isolated impingement; radiographs must be part of the workup to exclude other pathology; MRI is helpful to exclude other pathology; impingement is caused by a combination of all intrinsic, reduced acromiohumeral distance, mechanical impingement, and muscle weakness; the first line of treatment should always be physiotherapy; corticosteroid injection is helpful; an indication for surgery is failure of nonoperative treatment for 6 months; a local anesthetic injection (with or without steroid) is a useful tool to determine whether surgery is indicated (for nonoperative failures); anterior–superior escape is unlikely even if the coracoacromial ligament (CAL) is released; patients with a correct diagnosis with no other pathology and nonresponse to conservative treatment will benefit from surgery; mainly patients older than 50 years of age will benefit; surgical success can be determined at 6 months if patients return to full activities with no pain; and, SAD is a good choice for shoulder impingement if there is evidence of mechanical impingement with pain not responding to nonsurgical measures.

The NAP agreed that anterolateral pain with overhead movement and forward flexion is strongly suggestive of impingement (NAP 89%; EP 50%); routinely prescribed NSAIDs (NAP 84%; EP 61%); that night pain is a good indication for steroid injections (NAP 84%; EP 67%); that mechanical impingement is only an indication for surgery if patients do not respond to nonoperative measures (NAP 84%; EP 67%); and, that SAD is a good choice for shoulder impingement if nonsurgical measures fail (NAP 84%; EP 72%). The EP would not consider SAD in the presence of stiffness (EP 83%; NAP 53%).

Forty-four items reached agreement of less than 70%, and 8 items reached agreement between 70% and 80%. Surgeons outside these consensus percentages were invited to reconsider their response in round 4. However, none of the participating surgeons in fact considered changing their response.

Discussion

In this Delphi Expert Panel Consensus exploring shoulder impingement in patients with an intact rotator cuff, consensus could only be reached for 22% of the 71 Likert style items when pooling the 2 panels (NAP, EP).

Table 1. Delphi Round 1 Questions

[1] How do you define impingement and how do you diagnose it. Please comment on your clinical and radiological criteria.
[2] Impingement or rotator cuff tendinitis? What is your view?
[3] What is your first line of treatment? Can you please outline your protocol?
[4] What are the indications for corticosteroid injections and when do you consider it?
[5] What are your indications for surgery?
[6] In your personal opinion who will benefit from surgery and who will not? Is there evidence to support your view?
[7] Can you very briefly describe your technique for subacromial decompression. Specifically, do you release the coracoacromial ligament? Please reason why or why not.
[8] How do you measure whether surgery was a success? What do you consider the minimal follow up period to call it success or failure?
[9] Do you routinely measure the critical shoulder angle on radiographs and consider a lateral acromioplasty if the CSA is increased?
[10] Can you briefly comment on the potential cost-benefit of subacromial decompression
[11] Some publications have argued that subacromial decompression is harmful and has no benefit. Can you please comment.

CSA, critical shoulder angle.

The most important items where consensus was reached included that impingement is a clinical diagnosis, and that a combination of clinical tests should be used for diagnosis. Other pain generators must be excluded. Radiographs must be part of the work up and MRI is helpful. The first line of treatment should always be physiotherapy and corticosteroid injections are helpful in reducing symptoms. The indication for surgery is failure of nonoperative treatment for a minimum of 6 months. The panel also agreed that SAD is a good choice for shoulder impingement if there is evidence of mechanical impingement with pain not responding to nonsurgical measures.

However, the NAP and EP differed in opinion in various items. In contrast to the Europeans (50%), 89% of the North Americans believed that anterolateral pain with overhead movement and forward flexion is strongly suggestive of impingement. The North Americans were also more likely to routinely prescribe NSAIDs (NAP 84%; EP 61%) and also believed that night pain is a good indication for corticosteroids, and disagreed that steroids should not be considered at all. The timing and frequency of steroid injections did not reach consensus in both NAP and EP, and appears to be based on personal preference. The reason for these differences is not clear but could possibly be related to the patients seen at the individual practices. One might expect that surgeons who treat patients who are more community-based rather than more complex tertiary and quaternary patients in academic institutions would prescribe NSAIDs and inject corticosteroids more often. Surprisingly, the NAP included only 31% of surgeons who are community-based, whereas 59% of the European surgeons were community-based. Perhaps the EP was more concerned that corticosteroid injections do not provide adequate pain relief, cannot modify the natural course of the disease, may accelerate tendon degeneration, and can induce full-thickness tears.[23,24] Another possible explanation may lie in the fact that patients have different expectations and perceptions of pain. Zaslansky et al.[25] stated that North American patients reported greater pain intensity scores when undergoing orthopaedic surgical procedures.

Table 2. Delphi Round 2 Questions

[1.1]	If patients are diagnosed with impingement, radiographs should be ordered?
[1.2]	In the presence of stiffness or severely limited ROM, the impingement signs are unreliable and not helpful.
[1.3]	Is there a role for an MRI scan?
[3.1]	Timing of steroids. Is there is good reason to inject corticosteroids prior to physical therapy? Please comment briefly.
[3.2]	An argument against steroids could be that with initial penetration of the subacromial space the bursa is inflamed, obliterated, and fibrous tissue will not allow visualization. Blind, even if ultrasound-guided injections will not dilute but stay in a very small space, limiting its use. What is your view?
[4.1]	How many cortisone injections are useful and when to stop.
[5.1]	Patients who underwent 6 months of nonoperative treatment with sufficient physical therapy, a course of NSAIDs and persistent positive impingement signs (Jobe, Neer, and Hawkins–Kennedy) shoulder undergo subacromial decompression.
[5.2]	Which of the following symptoms would swing your indication towards surgery with the aforementioned scenario? A yes/no response is sufficient:
	[a] night pain
	[b] positive response to steroids or local anesthetic subacromial injection
	[c] reduced ROM
	[d] no response to nonsteroidal anti-inflammatory drugs NSAIDs
	[e] partial bursal-sided RC tear with no indication for repair
	[f] age—what is your cut-off?
	[g] mechanical outlet impingement on radiographs
	[h] others?
[5.3]	Is there an indication for subacromial decompression if patients with the history as described in [5.1] have generalized laxity.
[5.4]	Is there any other scenario where you would not operate?
[5.5]	Is there any other scenario where surgery is an absolute indication?
[5.7]	Should we consider an injection of local anesthetic with or without cortisone as a tool to evaluate whether subacromial decompression will be useful or not?
[6.1]	Would you consider SAD and bursectomy only in patients with calcific tendinitis with obvious impingement signs and night pain?

MRI, magnetic resonance imaging; NSAIDs, nonsteroidal anti-inflammatory drugs; RC, rotator cuff; ROM, range of motion; SAD, subacromial decompression.

Table 3. Pooled Results for the North American and European Panel

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Consensus (Percentage)
Diagnosis						
Impingement is a clinical diagnosis by clinical examination and history taking	23	9	3	2	0	**91**
The best clinical test is Jobe/empty can	1	4	17	14	1	40
The best clinical test is Neer	1	11	20	5	0	34
The best clinical test is Hawkins–Kennedy	5	11	16	3	2	43
A combination of tests should be used	24	9	3	1	0	**92**
A painful arc (between 60-120° abduction) is both sensitive and specific	0	8	16	12	1	35
Anterolateral pain with overhead movement and forward flexion is strongly suggestive of impingement	3	21	8	4	1	65
Other pain generators: calcific tendinitis, long head biceps pathology, RC tear, ACJ OA must be absent	19	12	0	5	1	**84**
However, the aforementioned pain generators do not exclude impingement	15	15	4	3	0	**81**
Night pain is an important indicator of impingement	2	19	12	4	0	57
Imaging						
Radiographs must be part of the work up to exclude other pathology	28	8	1	0	0	**97**
The CSA should always be measured	4	5	16	9	3	25
If the CSA is increased, I would consider a lateral acromioplasty	2	2	19	9	5	38
If the CSA is increased, a lateral acromioplasty should be strongly considered	2	8	20	4	3	27
MRI is helpful to exclude other pathology	25	12	0	0	0	**100**
MRI scans should be part of the initial work-up	4	7	11	13	2	40
MRI scans should only be done if initial treatment fails	5	13	10	7	2	49
Impingement or tendinitis? What comes first?						
Begins with tendinopathy (intrinsic causes)	6	15	14	2	0	57
Soft-tissue impingement cause pain and loss of motion (reduced space)	4	21	9	3	0	67
Outlet impingement due to spurs, Bigliani type III (mechanical impingement)	2	23	8	4	0	67
Impingement due to cuff weakness (muscular)	3	24	9	1	0	72
Combination of all above	15	17	5	0	0	**86**
Treatment						
First line of treatment should always be physiotherapy	21	13	2	1	0	**92**
In cases with severe pain, night pain, failed self-medication, and/or previous episodes I consider early surgery rather than PT and/or steroids	3	5	3	22	4	69
I routinely prescribe NSAIDs	4	23	3	2	4	70
Corticosteroid injection is helpful	14	18	3	1	1	**86**
I inject before physical therapy to aid with treatment	6	15	8	7	1	56
I will only inject if the response to physical therapy is poor	2	5	7	19	4	62
I only inject when severe pain is present (either before or after PT)	6	16	7	6	2	59
Steroid injections can be repeated up to 3 times	7	14	9	6	1	57
I only inject once	3	9	11	9	5	33
I do not repeat steroid injections if there is no response to the first injection	6	17	4	8	2	62
Night pain is a good indication for steroid injections	7	21	6	2	1	76
I also consider steroids as a diagnostic tool	4	13	5	12	3	46
I would not consider steroids for impingement	3	3	2	18	11	**84**
Stiffness						
Impingement can result in stiffness (loss of glenohumeral motion in particular external rotation and lateral abduction)	5	17	2	9	4	59
Before considering subacromial decompression patients must have full or nearly full range of motion	9	16	6	4	2	67
I consider subacromial decompression in the presence of stiffness	1	7	4	18	7	67
I consider subacromial decompression in the presence of stiffness if PT has failed	3	5	6	17	6	62

(continued)

Table 3. Continued

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Consensus (Percentage)
I consider subacromial decompression in the presence of stiffness but also perform MUA and releases	8	10	4	10	5	49
Indications for surgery						
Failure of nonoperative treatment for 6 months	12	19	3	1	2	**86**
Failure of nonoperative treatment for 3 months	2	15	8	10	2	46
I would consider earlier surgery if patients do not respond to NSAID, steroid injection and/or PT	4	11	7	14	1	40
I will not perform subacromial decompression for isolated shoulder impingement	2	6	4	18	7	67
Mechanical impingement is an indication for surgery	4	17	6	9	1	57
Mechanical impingement is only an indication for surgery if patients do not respond to nonoperative measures	9	18	5	4	1	73
There is no indication for surgery unless there is other identifiable pathology that needs surgery	4	6	2	18	7	67
Generalized and multidirectional laxity (Beighton score >4) is a contraindication for surgery	12	11	9	4	1	62
Calcific tendinitis is an indication for isolated cases in symptomatic patients	4	5	10	14	4	49
A local anesthetic injection (with or without steroid) is a useful tool to determine whether surgery is indicated (for nonoperative failures)	12	21	1	2	1	**89**
Surgical technique						
A bursectomy is sufficient; subacromial decompression is of no great value	0	6	4	17	10	72
The CAL should be released	7	9	12	4	5	43
I do not release the CAL; anterosuperior escape is a concern	3	6	5	18	5	62
I debride the CAL only	2	8	6	15	6	57
Even if the CAL is released, anterosuperior escape is unlikely	10	20	5	2	1	**83**
Ablation of the resected bone be should be performed to avoid bleeding and bone growth	3	6	9	16	3	51
I do not ablate the resected bone	9	9	7	9	3	51
Who will benefit from surgery?						
Correct diagnosis, no other pathology and failed conservative treatment	19	16	3	0	0	**94**
Good response to steroids or a diagnostic local anesthetic injection	9	20	4	1	3	78
Patients younger than 50 years with correct diagnosis, no other pathology and failed conservative treatment	8	16	8	5	0	65
Patients older than 50 years with correct diagnosis, no other pathology and failed conservative treatment	8	23	4	2	0	**84**
How to measure surgical success						
If the diagnosis is correct there will be almost immediate relief	2	7	5	23	0	62
At 3 months with return to full activities with no pain	4	19	10	4	0	62
At 6 months with return to full activities with no pain	13	20	4	0	0	**89**
General						
Subacromial decompression is a good choice for shoulder impingement if nonsurgical measures fail	9	20	3	4	1	78
Subacromial decompression is a good choice for shoulder impingement if there is evidence of mechanical impingement with pain not responding to nonsurgical measures	15	19	1	2	0	**92**
Subacromial decompression has good outcomes and reliable long-term results	8	18	6	5	0	70
Subacromial decompression is a cost-effective procedure	6	15	9	5	2	57
Studies that argue that subacromial decompression is harmful and has no benefits have multiple biases and should be viewed with caution	10	11	8	6	2	57
The current evidence is not helpful with regards to subacromial decompression for isolated shoulder impingement	10	9	9	9	0	51

Bold indicates the item that has reached consensus.

ACJ, acromioclavicular joint; CAL, coracoacromial ligament; CSA, critical shoulder angle; MRI, magnetic resonance imaging; MUA, manipulation under anesthesia; NSAIDs, nonsteroidal anti-inflammatory drugs; OA, osteoarthritis; PT, physical therapy RC, rotator cuff; ROM, range of motion.

Table 4. North American Results

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Consensus (Percentage)
Diagnosis						
Impingement is a clinical diagnosis by clinical examination and history taking	13	3	1	2	0	**84**
The best clinical test is Jobe/empty can	1	1	11	5	1	31
The best clinical test is Neer	0	6	10	3	0	32
The best clinical test is Hawkins–Kennedy	4	4	9	1	1	42
A combination of tests should be used	13	5	1	0	0	**95**
A painful arc (between 60-120° abduction) is both sensitive and specific	0	1	9	8	1	50
Anterolateral pain with overhead movement and forward flexion is strongly suggestive of impingement	2	15	1	1	0	**89**
Other pain generators: calcific tendinitis, long head biceps pathology, RC tear, ACJ OA must be absent	11	6	0	2	0	**89**
However, the aforementioned pain generators do not exclude impingement	7	7	3	2	0	74
Night pain is an important indicator of impingement	2	8	6	3	0	53
Imaging						
Radiographs must be part of the work up to exclude other pathology	16	3	0	0	0	**100**
The CSA should always be measured	1	3	9	4	2	31
If the CSA is increased, I would consider a lateral acromioplasty	1	0	9	7	2	50
If the CSA is increased, a lateral acromioplasty should be strongly considered	1	5	9	2	2	31
MRI is helpful to exclude other pathology	14	5	0	0	0	**100**
MRI scans should be part of the initial work-up	0	3	8	8	0	42
MRI scans should only be done if initial treatment fails	5	8	4	2	0	68
Impingement or tendinitis? What comes first?						
Begins with tendinopathy (intrinsic causes)	3	8	8	0	0	58
Soft-tissue impingement cause pain and loss of motion (reduced space)	1	12	4	2	0	68
Outlet impingement due to spurs, Bigliani type III (mechanical impingement)	0	13	4	2	0	68
Impingement due to cuff weakness (muscular)	1	12	6	0	0	68
Combination of all above	9	8	2	0	0	**89**
Treatment						
First line of treatment should always be physiotherapy	12	5	1	1	0	**89**
In cases with severe pain, night pain, failed self-medication and/or previous episodes I consider early surgery rather than physical therapy and/or steroids	2	2	3	12	0	63
I routinely prescribe NSAIDs	2	14	0	1	2	**84**
Corticosteroid injection is helpful	7	9	2	1	0	**84**
I inject before physical therapy to aid with treatment	2	9	6	2	0	58
I will only inject if the response to PT is poor	0	3	4	10	2	63
I only inject when severe pain is present (either before or after PT)	3	10	5	0	1	68
Steroid injections can be repeated up to 3 times	2	7	6	4	0	50
I only inject once	1	6	5	6	1	37
I do not repeat steroid injections if there is no response to the first injection	2	11	4	1	0	68
Night pain is a good indication for steroid injections	4	12	2	1	0	**84**
I also consider steroids as a diagnostic tool	2	11	0	5	1	68
I would not consider steroids for impingement	0	1	1	9	8	**89**
Stiffness						
Impingement can result in stiffness (loss of glenohumeral motion in particular external rotation and lateral abduction)	1	10	1	4	3	58
Before considering subacromial decompression patients must have full or nearly full range of motion	6	8	3	2	0	74
I consider subacromial decompression in the presence of stiffness	0	5	4	9	1	53
I consider subacromial decompression in the presence of stiffness if PT has failed	1	3	5	9	1	53

(continued)

Table 4. Continued

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Consensus (Percentage)
I consider subacromial decompression in the presence of stiffness but also perform MUA and releases	5	5	3	5	1	53
Indications for surgery						
Failure of nonoperative treatment for 6 months	7	9	1	2	0	**84**
Failure of nonoperative treatment for 3 months	1	10	3	3	2	58
I would consider earlier surgery if patients do not respond to NSAID, steroid injection, and/or PT	2	7	4	5	1	47
I will not perform subacromial decompression for isolated shoulder impingement	1	4	0	11	3	73
Mechanical impingement is an indication for surgery	2	10	3	3	1	63
Mechanical impingement is only an indication for surgery if patients do not respond to nonoperative measures	5	11	2	1	0	**84**
There is no indication for surgery unless there is other identifiable pathology that needs surgery	1	2	1	11	4	79
Generalized and multidirectional laxity (Beighton score >4) is a contraindication for surgery	6	5	5	2	1	58
Calcific tendinitis is an indication for isolated cases in symptomatic patients	1	4	5	6	3	47
A local anesthetic injection (with or without steroid) is a useful tool to determine whether surgery is indicated (for nonoperative failures)	6	12	1	0	0	**95**
Surgical technique						
A bursectomy is sufficient; subacromial decompression is of no great value	0	2	4	8	5	68
The CAL should be released	4	5	6	1	3	47
I do not release the CAL; anterosuperior escape is a concern	0	4	3	9	3	63
I debride the CAL only	0	4	4	9	2	58
Even if the CAL is released, anterosuperior escape is unlikely	8	8	3	0	0	**84**
Ablation of the resected bone be should be performed to avoid bleeding and bone growth	1	2	5	9	2	58
I do not ablate the resected bone	7	4	5	2	1	58
Who will benefit from surgery?						
Correct diagnosis, no other pathology and failed conservative treatment	9	9	1	0	0	**95**
Good response to steroids or a diagnostic local anesthetic injection	6	12	1	0	0	**95**
Patients younger than 50 years with correct diagnosis, no other pathology and failed conservative treatment	4	8	5	2	0	63
Patients older than 50 years with correct diagnosis, no other pathology and failed conservative treatment	4	12	2	1	0	**84**
How to measure surgical success						
If the diagnosis is correct there will be almost immediate relief	1	2	4	10	2	63
At 3 months with return to full activities with no pain	2	11	3	3	0	68
At 6 months with return to full activities with no pain	9	9	1	0	0	**95**
General						
Subacromial decompression is a good choice for shoulder impingement if nonsurgical measures fail	6	10	1	2	0	**84**
Subacromial decompression is a good choice for shoulder impingement if there is evidence of mechanical impingement with pain not responding to nonsurgical measures	9	8	1	1	0	**89**
Subacromial decompression has good outcomes and reliable long-term results	7	7	4	1	0	74
Subacromial decompression is a cost-effective procedure	5	9	3	2	0	74
Studies that argue that subacromial decompression is harmful and has no benefits have multiple biases and should be viewed with caution	3	8	5	3	0	58
The current evidence is not helpful with regards to subacromial decompression for isolated shoulder impingement	5	7	7	0	0	63

Bold indicates the item that has reached consensus.

ACJ, acromioclavicular joint; CAL, coracoacromial ligament; CSA, critical shoulder angle; MRI, magnetic resonance imaging; MUA, manipulation under anesthesia; NSAIDs, nonsteroidal anti-inflammatory drugs; OA, osteoarthritis; PT, physical therapy RC, rotator cuff; ROM, range of motion.

Table 5. European Results

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Consensus (Percentage)
Diagnosis						
Impingement is a clinical diagnosis by clinical examination and history taking	10	6	2	0	0	**89**
The best clinical test is Jobe/empty can	0	3	6	9	0	50
The best clinical test is Neer	1	5	10	2	0	33
The best clinical test is Hawkins–Kennedy	1	7	7	2	1	50
A combination of tests should be used	11	4	3	1	0	**83**
A painful arc (between 60-120° abduction) is both sensitive and specific	0	7	7	4	1	39
Anterolateral pain with overhead movement and forward flexion is strongly suggestive of impingement	1	7	7	2	1	50
Other pain generators: calcific tendinitis, long head biceps pathology, RC tear, ACJ OA must be absent	8	6	0	3	1	**83**
However, the aforementioned pain generators do not exclude impingement	8	8	1	1	0	**89**
Night pain is an important indicator of impingement	2	11	6	1	0	72
Imaging						
Radiographs must be part of the work up to exclude other pathology	12	5	1	0	0	**94**
The CSA should always be measured	3	2	7	5	1	33
If the CSA is increased, I would consider a lateral acromioplasty	1	2	10	2	3	28
If the CSA is increased, a lateral acromioplasty should be strongly considered	1	3	11	2	1	22
MRI is helpful to exclude other pathology	11	7	0	0	0	**100**
MRI scans should be part of the initial work-up	4	4	3	5	2	50
MRI scans should only be done if initial treatment fails	0	5	6	5	2	39
Impingement or tendinitis? What comes first?						
Begins with tendinopathy (intrinsic causes)	3	7	6	2	0	56
Soft-tissue impingement cause pain and loss of motion (reduced space)	3	9	5	1	0	67
Outlet impingement due to spurs, Bigliani type III (mechanical impingement)	2	10	4	2	0	67
Impingement due to cuff weakness (muscular)	2	12	3	1	0	78
Combination of all above	6	9	3	0	0	**83**
Treatment						
First line of treatment should always be physiotherapy	9	8	1	0	0	**95**
In cases with severe pain, night pain, failed self-medication and/or previous episodes I consider early surgery rather than physical therapy and/or steroids	1	3	0	10	4	78
I routinely prescribe NSAIDs	2	9	4	1	2	61
Corticosteroid injection is helpful	7	9	1	0	1	**89**
I inject before physical therapy to aid with treatment	4	6	2	5	1	56
I will only inject if the response to PT is poor	2	2	3	9	2	61
I only inject when severe pain is present (either before or after physical therapy)	3	6	2	6	1	50
Steroid injections can be repeated up to three times	5	7	3	2	1	67
I only inject once	2	3	6	3	4	39
I do not repeat steroid injections if there is no response to the first injection	2	5	2	7	2	50
Night pain is a good indication for steroid injections	3	9	4	1	1	67
I also consider steroids as a diagnostic tool	2	2	5	7	2	50
I would not consider steroids for impingement	3	2	1	9	3	67
Stiffness						
Impingement can result in stiffness (loss of glenohumeral motion in particular external rotation and lateral abduction)	4	7	1	5	1	61
Before considering subacromial decompression patients must have full or nearly full range of motion	3	8	3	2	2	61
I consider subacromial decompression in the presence of stiffness	1	2	0	9	6	**83**
I consider subacromial decompression in the presence of stiffness if physical therapy has failed	2	2	1	8	5	72

(continued)

Table 5. Continued

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Consensus (Percentage)
I consider subacromial decompression in the presence of stiffness but also perform MUA and releases	3	5	1	5	4	50
Indications for surgery						
Failure of nonoperative treatment for 6 months	5	10	2	1	0	**83**
Failure of nonoperative treatment for 3 months	1	5	5	7	0	39
I would consider earlier surgery if patients do not respond to NSAIDs, steroid injection and/or physical therapy	2	4	3	9	0	50
I will not perform SAD for isolated shoulder impingement	1	2	4	7	4	61
Mechanical impingement is an indication for surgery	2	7	3	6	0	50
Mechanical impingement is only an indication for surgery if patients do not respond to nonoperative measures	4	7	3	3	1	67
There is no indication for surgery unless there is other identifiable pathology that needs surgery	3	4	1	7	3	56
Generalized and multi-directional laxity (Beighton score >4) is a contraindication for surgery	6	6	4	2	0	67
Calcific tendinitis is an indication for isolated cases in symptomatic patients	3	1	5	8	1	50
A local anesthetic injection (with or without steroid) is a useful tool to determine whether surgery is indicated (for non-operative failures)	6	9	0	2	1	**83**
Surgical technique						
A bursectomy is sufficient; subacromial decompression is of no great value	0	4	0	9	5	78
The CAL should be released	3	4	6	3	2	39
I do not release the CAL; anterosuperior escape is a concern	3	2	2	9	2	61
I debride the CAL only	2	4	2	6	4	56
Even if the CAL is released, anterosuperior escape is unlikely	2	12	2	2	0	**78**
Ablation of the resected bone be should be performed to avoid bleeding and bone growth	2	4	4	7	1	50
I do not ablate the resected bone	2	5	2	7	2	50
Who will benefit from surgery?						
Correct diagnosis, no other pathology and failed conservative treatment	10	7	1	0	0	**94**
Good response to steroids or a diagnostic local anesthetic injection	3	8	3	1	3	61
Patients younger than 50 years with correct diagnosis, no other pathology and failed conservative treatment	4	8	3	3	0	67
Patients older than 50 years with correct diagnosis, no other pathology and failed conservative treatment	4	11	2	1	0	**83**
How to measure surgical success						
If the diagnosis is correct there will be almost immediate relief	1	5	1	11	0	61
At 3 months with return to full activities with no pain	2	8	7	1	0	56
At 6 months with return to full activities with no pain	4	11	3	0	0	**83**
General						
Subacromial decompression is a good choice for shoulder impingement if nonsurgical measures fail	3	10	2	2	1	72
Subacromial decompression is a good choice for shoulder impingement if there is evidence of mechanical impingement with pain not responding to nonsurgical measures	6	11	0	1	0	**94**
Subacromial decompression has good outcomes and reliable long-term results	1	11	2	4	0	67
Subacromial decompression is a cost-effective procedure	1	6	6	3	2	39
Studies that argue that subacromial decompression is harmful and has no benefits have multiple biases and should be viewed with caution	7	3	3	3	2	56
The current evidence is not helpful with regards to subacromial decompression for isolated shoulder impingement	5	2	2	9	0	50

Bold indicates the item that has reached consensus.

ACJ, acromioclavicular joint; CAL, coracoacromial ligament; CSA, critical shoulder angle; MRI, magnetic resonance imaging; MUA, manipulation under anesthesia; NSAIDs, nonsteroidal anti-inflammatory drugs; OA, osteoarthritis; PT, physical therapy RC, rotator cuff; ROM, range of motion.

There was no agreement whether impingement can cause stiffness. Sixty percent of the panel believed that there is a possible relationship. In contrast to the NAP the Europeans were more likely to not consider SAD in the presence of stiffness (EP 83%; NAP 53%). This difference may reflect an unspecified bias in training and education that reflects local standards but otherwise remains unexplained.

There was no agreement regarding which clinical diagnostic test is preferred. The Europeans placed a slightly greater value on the Jobe test, and just more than 40% of both Europeans and North Americans believed that the Hawkins–Kennedy test has high diagnostic value. Both panels agreed that a combination of tests should be used, and these findings agree with the current evidence. The reported sensitivity for the impingement tests ranges from 59% to 92%, with a specificity of approximately 70% providing strong support for using a combination of tests.[26,27]

Since the original impingement classification by Neer,[1] there has been considerable controversy as to whether impingement is caused by inflammatory changes in the tendon, or if instead impingement results in tendinitis.[28] There was no agreement here, and a similar percentage of the North American and European panelists believed that the reasons are multifactorial, with a combination of soft-tissue impingement, mechanical outlet impingement, and cuff weakness contributing to the impingement syndrome. The pathomechanics of impingement syndrome are still unclear, and the assumption that contact with the acromion causes secondary changes in the tendon remains unproven.[28]

There is strong consensus that the first line of treatment should always be physiotherapy, and neither the European nor North American panelists would consider earlier surgery if severe pain, including night pain, does not resolve with medication. The optimal timing of surgical intervention is not clear, and current studies have suggested a minimum of 3 to 6 months of nonoperative treatment.[3,29] However, 50% of the European and 47% of the North American surgeons would consider earlier surgery if patients do not respond to NSAIDs, steroid injection, and/or physical therapy.

There is consensus that nonoperative treatment should be attempted for at least for 6 months. However, if conservative measures fail, surgery should be considered. Sixteen of the 19 (84%) NAP members and 15 of the 18 (83%) EP members will consider surgery if nonoperative treatment with appropriate physical therapy, NSAIDs, and steroid injections do not result in the resolution of impingement symptoms. Both the NAP and EP agreed that a local anesthetic injection with or without corticosteroid is a useful tool to determine whether surgery should be considered. Interestingly, nearly 50% of North American and European surgeons would consider earlier surgery if patients do not respond to nonoperative measures, although 61% of the European panel compared with 73% of the NAP would not consider SAD for isolated impingement. Generalized laxity and calcific tendinitis are general contraindications for surgery for 60% respectively 49% of the panel. Obviously, the current available evidence is not compelling. Possibly the individual surgeon may base his or her decisions on personal experience and other factors, and may also be biased when interpreting the published literature.[12,30] The moderate differences between NAP and EP with regard to the indications for surgeries, but also preferences to treat conditions surgically, are likely caused by different training and experience, different cultural and health environments, and different practice patterns that inevitably influence our beliefs and behavior.[31]

These differences also may account for the individual preferences relating to surgical techniques. Although there was consensus that release of the CAL is unlikely to cause anterosuperior escape, 62% would not release the CAL whereas 43% routinely release the CAL. Similarly, 50% would ablate the resected bone and 50% would not. Although there was no consensus, the majority of surgeons believed that a bursectomy alone is not of value. This is in clear contrast to 2 previous controversial studies that could not demonstrate an advantage of SAD and bursectomy compared with bursectomy alone.[32,33] The systematic review by Donigan and Wolf[32] included 6 Level I and II studies, but the conclusions are still limited due to the poor quality of the included studies. Kolk et al.[33] compared acromioplasty and bursectomy to bursectomy alone, and reported there was no additional benefit of acromioplasty over bursectomy alone; however, lower VAS scores were observed in the acromioplasty group.

There was consensus that patients older than 50 years old with the correct diagnosis will benefit from surgery, and that surgery can be considered to be successful if patients return to full activities at 6 months with no pain. Both the NAP and EP believed that a good response to steroids or a diagnostic local anaesthetic injection is a predictor of success. Finally, there was consensus in the NAP and near consensus in the EP that SAD is a good choice for shoulder impingement if nonsurgical measures fail, and consensus that SAD is a good choice for mechanical impingement. Despite consensus, the panel seems to be unsure whether the outcomes are reliable and sustainable, and only two-thirds of both the NAP and EP believe that SAD results in good long-term outcomes.

Unfortunately, this Delphi study failed to achieve consensus for the majority of the items. It appears that the panel was not sure that the current evidence is sufficient to reliably diagnose and treat isolated shoulder impingement. Interestingly, none of the surgeons who were invited to change their response in round 4

made any changes. Obviously, extensive clinical and surgical experiences as to what works best for them and possibly an element of myside bias are potential explanations for this behavior, even if a majority of peers were of a different opinion. Surgeons may have also been strongly opinionated, stating "I always do so," or "it works in my hands."

Approximately one-half of the panel believed that the current evidence is not helpful, may be biased, and should be viewed with caution. Evidence-based medicine is defined as the "integration of best research evidence with clinical expertise and patient value."[34] If the evidence is not clear, subjective interpretation, myside and confirmation bias, and our own clinical experiences are the likely factors guiding us in making treatment recommendations, and this process can be inherently flawed.[30,31,35] The Delphi panel method has been criticized as representing only the lowest common denominator.[16,17] However, the methodology of Delphi is well-established and valid, in particular when the evidence is limited.[36-38]

Shoulder impingement is a common diagnosis, but variations in the presenting signs may lead to clinical uncertainty,[39] and clinicians from different professional backgrounds tend to disagree as to the definition of shoulder impingement,[40] making it even more difficult to reach consensus. This is further complicated by potential inconsistencies in the selection of study participants.[39]

Limitations

This study has inherent limitations. Consensus only reflects agreement at a specific point in time and may change with new evidence or experience.[19] The Delphi panel method has been shown to be reproducible but is more consistent when there is a stronger evidence base.[41] Given the unclear and non-compelling evidence available, personal opinions may have played a larger role when responding to the individual items here, and future studies may change the consensus in either direction. Despite careful selection of panel members and following the Delphi methodology rigorously, the results of this consensus clearly cannot define the opinion of the entire orthopaedic community, but has instead aimed at providing the best possible synthesis of the opinion of a select group of experts at one point in time.[19] The majority of the panel members were based in academic institutions or had academic affiliations, which could have caused selection bias. However, when comparing the total number of community-based surgeons between the 2 continents, the number was very similar with 2 community-based surgeons on each continent, and the remaining members of the panel were academics or had academic affiliations. This composition seems to reflect the selection criteria, as it would be unlikely that many community-based surgeons would publish or presents abstracts at national and international meetings. Although every effort was made to include only specialized shoulder surgeons as panel members, the volume of shoulder surgery of each participant was not explicitly quantified and could be seen as another limitation.

Conclusions

Consensus was achieved for 16 of the 71 Likert items: impingement is a clinical diagnosis and a combination of clinical tests should be used. The first line of treatment should always be physiotherapy, and a corticosteroid injection can be helpful in reducing symptoms. The indication for surgery is failure of non-operative treatment for a minimum of 6 months. The panel also agreed that SAD is a good choice for shoulder impingement if there is evidence of mechanical impingement with pain not responding to non-surgical measures.

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