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Open and arthroscopic excision of the distal clavicle for osteoarthritis of the acromioclavicular joint--results over 5 years

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ABSTRACT

Objective: Initially performed as open surgery, arthroscopic applications of distal clavicle excision (DCE) have gained prevalence in recent years. Literature reviews about the long-term results give no clear indication that one method is superior to the other. This study aims to compare the follow-up results of patients treated with arthroscopic and open DCE for more than five years and to detect the superiority of each method.

Material and Method: The study involved 328 patients treated with DCE between February 2008 and April 2017. One hundred and fourteen patients (66 male and 48 female; 81 arthroscopic and 33 open surgery), who had their records available and underwent no other surgery than DCE, were included in the study. The Disability of the Arm, Shoulder, and Hand (DASH) score and Visual Analogue Scale (VAS) were used to assess post-DCE shoulder functions and pain, respectively. Within the study's scope, surgery duration, excision extent, complications (frozen shoulder, hematoma, surgical site infection, and instability), and revisions were compared.

Results: In the >5-year follow-up process, no statistically significant difference was observed between pre-DCE DASH and VAS values or between post-DCE DASH and VAS values of the two groups, one involving 32 patients who underwent open surgery and the other involving 82 patients treated with arthroscopic surgery. However, there was a statistically significant difference between the pre- and post-DCE DASH and VAS scores of both groups, and it was observed that both surgical methods were effective. No statistically significant difference was observed between the two groups regarding the surgery duration. Arthroscopic DCE was measured to be 4.70 mm on average, while the average measure for open surgery was 5.53 mm, which indicated a statistically significant difference between the two groups. However, no significant association was observed between the excision extent and the DASH and VAS scores. Furthermore, no significant difference was observed between complication and revision rates.

Conclusion: In the >5-year follow-up of patients who underwent arthroscopic or open DCE due to their acromioclavicular joint osteoarthritis, which could not be treated with conservative treatment, no statistically significant difference was observed in the two groups' post-DCE DASH scores, VAS scores, complication rates, and revision rates. There was, however, a statistically significant difference between both groups' pre- and post-DCE VAS and DASH scores, and both methods were effective.

Key words: *Acromioclavicular, distal clavicle excision, arthroscopic, open*

Introduction

Acromioclavicular (AC) joint osteoarthritis (OA) causes subchondral cystic lesions at the clavicle's distal end, joint enlargement, and pressure due to inferior osteophytes [1]. Neer identified OA development in the AC joint as one of the etiological factors of shoulder impingement syndrome, drawing attention to the concurrence of AC joint OA and impingement syndrome.

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Accordingly, conservative and surgical treatment methods were reported to be applicable [2].

Even though conservative treatment is usually the first option that comes to mind, open and arthroscopic applications of distal clavicle excision (DCE) were effective in the surgical treatment of AC joint OA, which is resistant to conservative treatment [3,4]. Mumford first described the open DCE technique [5]. However, in recent years, open surgical treatment has lost its prevalence due to concerns about large excisions, superior capsule and ligament damage, and the development of instability, while arthroscopic DCE applications have increased in number [6].

Studies comparing these two methods are usually based on short- and medium-term results. In the literature, there are very few publications in terms of long-term clinical follow-up results.

Even though the studies focusing on short-term follow-up results reported lower pain scores for arthroscopy, no statistically significant difference was observed between the two groups regarding pain-related and functional results in the medium term [7,8]. The literature does not point to a general preference based on the results obtained from these two methods; instead, the factors considered were reported to be the patient's age and the surgeon's decision [7-9]. Arthroscopy protects the supra-posterior ligament and capsule, does not damage joint stabilization, relieves pain faster, and provides rapid functional recovery in the early period, which is why arthroscopic DCE has been opted for lately [10].

This study aims to compare the DASH scores, VAS scores, complication rates, and revision rates reflecting more than five years (long term follow up) of data from two groups treated with either open or arthroscopic DCE due to symptomatic AC joint OA.

Patients and Methods

A total of 328 patients, who did not respond to conservative treatment and underwent DCE between February 2008 and April 2017 due to AC joint OA refractory, were assessed retrospectively. One hundred and fourteen patients (66 male and 48 female) treated either with arthroscopic (81 patients) or open (33) surgery, who had their records available and who underwent no other surgery than DCE, were included in the study (Table 1). Informed consent forms were obtained from those involved in the study.

Exclusion criteria for the study included patients who underwent surgical operations for additional pathologies diagnosed at the same time as DCE (i.e., SLAP, Type 2-3 acromion, rotator cuff damage, and glenohumeral instability) and those who had previously undergone surgical treatment for the same shoulder area. Furthermore, patients who had previously high-energy shoulder trauma (AC joint dislocation, tuberculum majus fracture, shoulder dislocation, clavicle fracture) were excluded. Finally, patients whose shoulder movements were highly limited before the surgery due to a frozen shoulder were excluded from the study, considering it would affect post-surgery functional scoring.

Symptomatic patients who had at least one positive result in AC joint-specific tests (O'Brien's Test, cross-body adduction test, local pain in AC joint) before DCE were included in the study. For AC joint OA, the most frequent finding was joint enlargement, which causes upward skin bulges. All patients had local sensitivity and pain symptoms in the AC joint.

Patients diagnosed with symptomatic AC joint OA received at least four to six months of conservative treatment at orthopedic and physical therapy clinics. However, they failed to recover from symptoms, such as pain and limitation of movement, and decided to be treated with DCE. During their conservative treatments, patients were treated with non-steroidal anti-inflammatory drugs, physical therapy applications, and a combined local injection of methylprednisolone and lidocaine. The lidocaine test was applied to a limited number of patients, and AC joint pathology was verified before DCE.

Standard bidirectional shoulder radiographs, Zanca view radiography, and MRI were used for pre-operative radiological evaluation. Zanca view radiography was used to visualize the inferior AC joint's pressure better, and after surgery, a standard shoulder anteroposterior radiograph was taken for all patients. Eight patients underwent a follow-up MRI six months after the operation due to their complaints of pain.

The Kellgren-Lawrence classification was used for AC joint OA [11], and our study group consisted of patients with Kellgren-Lawrence grades of 2 and 3. Narrowing of the AC joint and the presence of subchondral cysts and osteophytes were used to determine the stage of OA. Stage 1 consisted of patients treated conservatively, while stage 4 involved patients with additional pathologies (i.e., rotator cuff damage and SLAP) that developed because of large osteophytes due to advanced OA. Stage 4 patients were excluded from the study since such additional pathologies would negatively affect the results of open DCE. Stage 2; consisted of marked osteophyte and unchanged joint space and in Stage 3; there was moderate narrowing of the joint space.

Surgical Procedure

Arthroscopic and open DCE applications were performed under general anesthesia and using a shoulder table with the patient in a semi-sitting position. Open surgeries were performed through a 2.5–4 cm incision over the AC joint. An entrance was made between the deltoid and trapezius muscles; then the anterior deltoid was dissected, and the clavicle's distal end region was separated from the soft tissues. The AC joint's superior ligament was opened longitudinally, and the subperiosteal was stripped. The posterior capsule and ligament were preserved, and instability was avoided. Then, the intra-articular degenerated meniscus was excised, along with the clavicle’s distal end for 4–6 mm, using an osteotome or a surgical saw. Any osteophytes likely to cause pressure in the acromion inferior were excised using a rongeur or a rasp. The coracoclavicular ligament and inferior AC ligament were preserved. Abduction, adduction, and internal and external rotation were performed on the arm, and it was ensured that there was no AC joint contact and that the DCE performed was adequate. Marcaine was injected locally. The capsule was repaired, and the delto-trapezoidal fascia was closed using an absorbable suture. The skin was stitched with a 3-0 Prolene suture, and the surgery was finalized. The patient was then taken to the unit with a shoulder arm sling and discharged the same day.

In arthroscopic DCE, the posterior portal was used for visualization purposes, while the procedure was applied through the mid-lateral and anterior portals. Arterial blood pressure was kept below 100 mmHg, and intra-articular pressure was maintained at 40–50 mmHg using an arthroscopy pump. A 0.9% sodium chloride solution (3,000 ccs) was used to control intra-articular pressure and irrigation. First, the glenohumeral, then the subacromial, and finally the AC joint was visualized. The AC joint was visualized through the subacromial region, pressure was applied to the clavicle's distal end region, and the AC joint region was detected. OA and inferior pressure at the clavicle’s distal end were observed in the AC joint, the inferior capsule was cut using electrocauterization, and the distal clavicle was stripped from anterior to posterior (Figure-1). The surgeon reached through the lateral portal and flattened the AC joint region from the inferior using a shaver, which was shifted to the anterior portal, and DCE was applied (Figure-2). An approximately 5 mm excision, large enough for the shaver to fit through, was made, and the posterior-upper ligament and capsular region were preserved to maintain AC joint stability (Figure-3). The shoulder was moved in all directions, ensuring that there was no joint contact in adduction and that the excision was adequate. A 10 cc Marcaine injection was administered through the arthroscopic portal, and the portals were closed with skin sutures. A standard anterior-posterior shoulder radiograph was taken (Figure-4), and the patient was discharged on the same day with a shoulder arm sling. The patients in both groups were operated by the same surgeon. As the

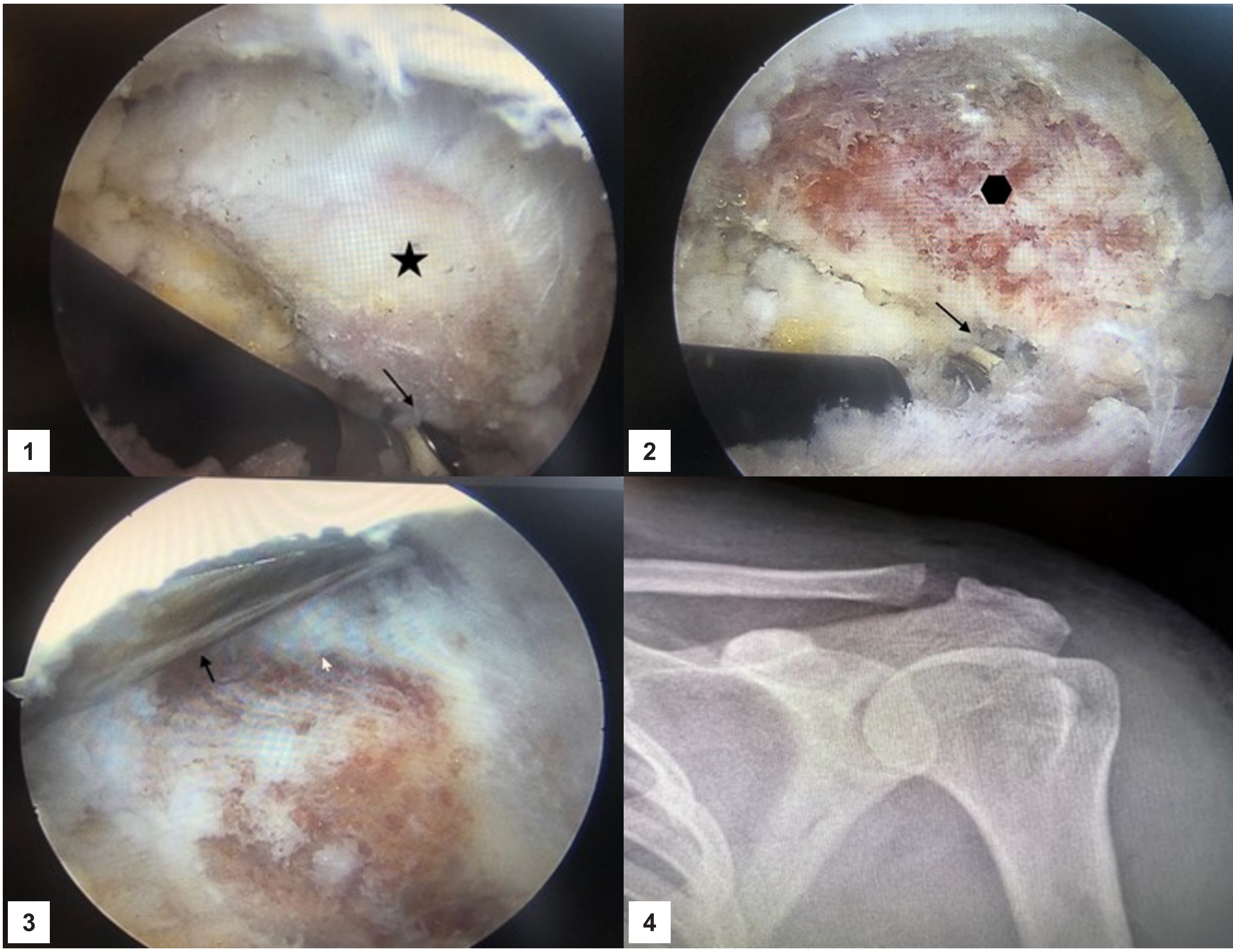

Figure. (1) OA in the AC joint and impingement at the clavicle's distal end (asterisk). Cutting the inferior capsule using electrocautery (arrow). **(2)** DCE (polygon) from the anterior portal using a shaver; excision of inferior soft tissues using electrocautery (arrow). **(3)** DCE to fit a shaver that is 5 mm in diameter (black arrow). Protection of the posterior-upper ligament and capsular region to maintain AC joint stability (white arrow). **(4)** Standard shoulder anteroposterior radiograph to see the extent of DCE.

experience of shoulder arthroscopy increased, open surgery was less preferred for DCE.

The day after the surgery, both groups initiated a pendular motion with active 90-degree abduction and forward flexion. The shoulder arm sling was removed after 10 to 14 days, and internal and external rotation movement started. During the first month, a physical therapy program was applied to the shoulder muscles. Patients were allowed to return to their daily lives in the second month, and resistance activities and non-contact sports were allowed in the third month. A local methylprednisolone Lidocaine injection was administered to the AC region of the patients who developed frozen shoulders after the DCE, and they were included in a physical therapy program in the early period.

Postoperative records of both groups were examined, and comparisons were made in terms of operation duration, excision length and complications, wound infection, post-operative bleeding, recurrence, inferior bone articulation, AC joint instability, frozen shoulder development, and revision surgery rates. To determine the excision extent, the AC joint distance in the pre-operative shoulder anteroposterior radiograph, available in the hospital information systems, was measured with millimetric precision and deducted from the AC joint distance in the post-operative shoulder anteroposterior radiograph. DASH [12] and VAS scores were used to assess shoulder functions and pain, respectively. The Ethics Committee of VM Medical Park Bursa Hospital approved this study with approval no. 2022-251. The authors declare that the study was conducted following the WMA Declaration of Helsinki (Ethical Principles for Medical Research Involving Human Subjects; amended in October 2013).

Statistical Analysis Frequency, mean, and standard deviation values were calculated using descriptive statistical methods. A T-test was applied to evaluate the differences between the two groups. Pearson's correlation coefficient was used to determine whether a significant correlation existed between the parameters. A two-tailed hypothesis was based on the analyses, and a p-value of ≤0.05 was accepted to indicate a statistically significant difference. SPSS 18.0 software for Windows (SPSS, Inc., Chicago, IL, USA) was used to evaluate statistical analyses.

Results

The mean age for arthroscopic and open DCE was 50.2 and 52.3 years, respectively, and the mean age was 51.6 years (range, 31-63). The mean age for female patients was 53.8 years (range, 34-63), while for male patients, the average age was 50.1 years (ranging from 31 to 59). No statistically significant difference between the two groups regarding gender and mean age was observed.

The average follow-up period for arthroscopic and open DCE groups was 110.5 months and 152.8 months, respectively. No statistically significant difference was observed between the two groups regarding their follow-up periods (p=0.952).

In the arthroscopic DCE group, pre- and post-operative VAS scores were 8.5 (range, 7-10) and 1.6 (range, 1-3), respectively, and this difference between pre- and post-operative scores was statistically significant (p<0.001). In the open DCE group, pre- and post-operative VAS scores were 8.8 (range, 8-10) and 1.8 (range, 1- 3), respectively. This difference between pre- and post-operative scores was also statistically significant (p<0.001). However, no statistically significant difference was observed in the groups regarding their post-operative VAS scores (p=0.233, p<0.001). The arthroscopy group reported less pain in the early period, but the open surgery group reported less pain the longer the follow-up period.

In the arthroscopic DCE group, pre- and post-operation DASH scores were 84.6 (range, 70-100) and 16.1 (range, 20-40), respectively. This difference between pre- and post-operative scores was also statistically significant (p<0.001). However, the average DASH score for the open DCE group went from 87.2 (range, 70-100) to 17.2 (range, 10-40) post-operation. This difference between pre- and post-operative scores was also statistically significant (p<0.001). No statistically significant difference was observed between the two groups regarding their post-operative DASH scores (p=0.732).

Table 1. Gender and age distribution of both groups who underwent DCE.

	DCE Method		
Sex	Open	Arthroscopic	Total
Female	11	37	48
Male	21	45	66
Total	32	82	114

Table 2. Statistical evaluation of the data pertaining to the groups.

	Open (N=32)	Artrhroscopic (N=82)	p
Age (Mean)	52,3	50,2	0,952
Mean Follow-up (Month)	152,8	110,5	0,586
Amount of Excision (mm)	5,53	4,70	0,000
Operation Time (Minute)	31,6	30,7	0,309
Preop. DASH Score	87,2	84,6	0,185
Postop. DASH Score	17,2	16,1	0,732
Preop. VAS Score	8,8	8,5	0,209
Postop. VAS Score	1,8	1,6	0,233

The mean DCE extent was measured to be 5.53 mm and 4.70 mm in open surgery and arthroscopy groups, respectively, which indicated a statistically significant difference between the two groups ($p=0.000$, $p<0.001$). A Pearson's correlation test was applied to both groups to determine the impact of the DCE extent on post-operative DASH and VAS scores, which indicated that the excision extent had no statistically significant impact on post-operative DASH and VAS scores ($P=0.163$ and $P=0.099$, respectively). It was further observed that post-operative VAS scores were significantly lower in male patients compared to female patients, regardless of the surgical technique used ($P=0.04$).

The duration of the surgeries that used open and arthroscopic procedures was measured as 31.6 and 30.7 minutes, respectively. Accordingly, no statistically significant difference was observed between the two groups. The number of complications was arthroscopic DCE groups 5 DCE (3 patients who underwent inadequate arthroscopic and 2 patient frozen shoulder) and 9 DCE (2 patients who underwent inadequate arthroscopic, 4 patient frozen shoulder, 3 patients infection) in open DCE. Statistically significant difference was not observed between the two groups.

Three arthroscopic DCE patients and one open DCE patient underwent open revision surgery, during which the clavicle's distal end was shortened and inferior osteophytes were excised. No statistically significant difference was observed between the two groups regarding their revision rates. The findings are presented in Table-2.

Discussion

During the >5year follow-ups of open and arthroscopic DCE groups, no statistically significant difference was observed in the groups' post-operative VAS and DASH scores. However, a statistically significant difference was observed between pre- and post-operative VAS and DASH scores of both groups. It was possible to diagnose and treat additional pathologies in the arthroscopic method, which was an advantage over open surgery. Our study's results suggest that the surgeon's experience in shoulder arthroscopy and open DCE would reduce the chances of inadequately viewing the arthroscopic AC joint and performing DCE poorly.

In their study comparing both methods' results, Bigliani et al. [13] reported that arthroscopic DCE had many advantages over open DCE, including less tissue damage, a better cosmetic look, less severe post-operative pain, a faster return to daily life, and increased patient satisfaction. However, another study argued that the arthroscopic procedure would provide a limited view of the AC joint's upper posterior region, leading to inadequate DCE and, consequently, residual pain and dysfunction (3). Our study's results suggest that the surgeon's experience in shoulder arthroscopy and open DCE would reduce the chances of inadequately viewing the arthroscopic AC joint and performing DCE poorly.

A study by Pensak et al. [3] reported that the pain experienced by patients in AC joint OA decreased by 79 percent and 91 percent in open and arthroscopic DCE, respectively, indicating that both methods were effective in relieving pain. Robertson et al. compared the results of two groups who underwent open or arthroscopic DCE with an average incision of 10 mm and reported no statistically significant difference between the functional results of the two groups. However, they argued that those treated arthroscopically experienced less pain in the post-operative period [8]. Another study found no statistically significant difference between the two groups regarding functional results and VAS pain score [14]. Our study concurred with this finding and revealed no statistically significant difference in post-operative VAS and DASH scores. It should be noted, however, that, unlike the studies mentioned above, our study evaluated results spanning more than five years.

A comparison was made between the group that underwent open DCE and the group that was treated with arthroscopic DCE, during which additional pathologies in the shoulder joint were treated and not excluded from the study. This inclusion resulted in the arthroscopy group having lower reported VAS scores [8]. Since our study excluded the arthroscopic DCE cases with additional pathologies, no results were reported regarding this.

A study investigating the association between the DCE extent and pain reported that approximately 10 mm of excision would reduce contact and pressure, leading to less pain. It was also reported that a DCE longer than 10 mm would increase the risk of instability and was associated with post-operative pain. The excision extent in the arthroscopy group was also reported to be significantly smaller than in the open surgery group [15]. However, another study argued that the DCE should be smaller than 10 mm to avoid the development of instability [16]. Another study argued that the excision was significantly more extensive in open DCE than in arthroscopic DCE and that the pain was significantly lower. However, they detected no statistically significant association between pain and excision size [17]. Flatow et al. excised an average of 18 mm in open DCE and 17 mm in arthroscopic DCE and reported that both treatment methods were successful [9]. However, a recent study suggested that a ≤5 mm DCE would be adequate for successful clinical and functional results and that any excision exceeding 5 mm may cause instability [18]. Open surgery was reported to have an advantage over arthroscopic DCE. Accordingly, in open surgeries, excision can be made following the amount planned before surgery, while in arthroscopic applications, the amounts may change at times [8,14]. Our study used two methods to measure the amount of arthroscopic DCE. The first method checked whether the 4 mm diameter shaver fit in the area where we applied DCE. In the second method, we inserted the spinal needle parallel to the AC joint using fluoroscopy and excised the spinal needle laterally using a shaver. To correctly measure the amount of open DCE, we first reached the clavicle, used the sheet prepared as a template to mark the amount of DCE we planned to excise, using a marker pen, and finally excised the relevant section.

In addition to their success rates, arthroscopic and open DCE methods were also compared in terms of complications. A recent study reported that the complication rate of open DCE was significantly higher than arthroscopic DCE (10.8 percent and 7.3 percent, respectively). However, complication rates of both groups were observed to be acceptably low. The complications investigated within this study's scope involved delayed wound healing, post-operative hematoma, need for transfusion, and infection at the injury site. However, the same study reported no statistically significant difference between the revision rates of arthroscopic (0.70 percent) and open (1.39 percent) DCE [19]. Our study did not reveal any statistically significant difference in complication or revision rates of either group.

However, another study reported 7.3 percent and 10.2 percent complication rates for open and arthroscopic DCE, respectively. The most common complications were surgical site infection (0–4.3 percent) and frozen shoulder (0–33 percent) for both methods [6]. In our study, considering both methods, the rates for frozen shoulder and surgical site infection requiring antibiotic therapy were 4.9–6 percent and 1.6–3 percent, respectively. In addition, both groups started active movement the day after the DCE operation, which suggests that this might be why our frozen shoulder rates were below the rates reported in the literature. A 2 g of cefazolin was administered intravenously to prevent intraoperative infection.

Basmania et al. [20] investigated the reasons behind failed DCE operations and categorized them. Accordingly, the causes of unsuccessful DCE operations include, but are not limited to, misdiagnosis, instability due to inadequate or over-excision, and weakness. However, they failed to present any ideas about the amount of DCE, the most common cause of failure. Insufficient excision may cause residual contact and pain in the AC joint, while excessive excision may lead to instability and pain due to ligament deficiency. In addition, the importance of protecting the joint capsule and ligaments was reported [21].

A study that reported no statistically significant difference between open and arthroscopic DCE argued that 65–79 percent of DCE operations were applied arthroscopically in recent years, making it an increasingly preferred procedure over open surgery [22]. It was also reported that open DCE might be preferred in cases and revisions with osteolysis at the distal clavicle end, which does not require imaging of the glenohumeral joint and subacromial region [4]. Our study also revealed an 87 percent increase in arthroscopic DCE application in the last three years, but open DCE was used in revisions.

Our study's strength was that the same surgeon, who also single-handedly assessed the results, applied both DCE methods. Since the surgeon had used both methods for a long time, it can be argued that the surgeon's inferences about the advantages and disadvantages of the techniques used and the results presented in the article were objective. By reviewing the videotapes of the cases, we applied arthroscopic DCE, detected additional pathologies, and excluded this patient group from the study. Other substantial aspects of our study were the study group's size and our follow-up period's duration.

Since this was a retrospective study, no randomization could be performed, which can be interpreted as a study limitation. The surgeon's command of both techniques was an influential factor in selecting the method. Accordingly, the first cases were treated with the open method, and upon gaining more experience in shoulder arthroscopy, the arthroscopic DCE method was preferred in recent years. Therefore, the groups' follow-up periods varied, though this variation was not statistically significant. On another note, no diagnostic arthroscopy was performed in the open DCE group. Therefore, no additional pathologies likely to affect the results were detected, which can be listed as another study limitation. Furthermore, the last follow-up of some of the patients was made over the phone, which was another limitation, and this was why we could not use the Constant score, which gives a more specific score.

In open DCE, the AC joint's upper ligament and capsule were damaged, while the inferior ligament and capsule were damaged in the arthroscopic DCE. In comparing the results of these two methods, we think that biomechanical or cadaveric studies that investigate the contribution of miscellaneous, damaged anatomical structures to joint stability are needed.

Conclusion

There was no statistically significant difference in the postoperative VAS and DASH scores of the open and arthroscopic DCE groups after a > 5-year follow-up. However, there was a statistically significant difference in both groups' preoperative and postoperative VAS and DASH scores.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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