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ORIGINAL STUDY

Systematic review and Meta-analysis on acromioplasty in arthroscopic repair of full-thickness rotator cuff tears

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The purpose of this study was to perform a systematic review and meta-analysis including all available randomized controlled trials to determine the role of acromioplasty in arthroscopic repair of full-thickness rotator cuff tears.

A literature search was conducted in PubMed, Embase, Cochrane, and Web of Science. All randomized and quasi-randomized controlled trials evaluating the outcomes of arthroscopic repair of full-thickness rotator cuff tears with or without acromioplasty were included in our meta-analysis. After the studies were selected by two reviewers, data were collected and extracted independently. Data were pooled for American Shoulder and Elbow Surgeons (ASES) score, Constant-Murley (CM) score, University of California-Los Angeles (UCLA) score, visual analog scale (VAS) for pain and reoperation rate.

Five prospective randomized studies involving 465 patients were included. The current meta-analysis did not show any significant difference between acromioplasty and nonacromioplasty groups with regard to the outcomes for ASES score, CM score, UCLA score (P = .17, .05, and .13, respectively). There was also no significant difference in VAS for pain and reoperation rate between the two groups (P = .87, and .57, respectively).

On the basis of the currently available evidence, there was no statistically significant difference in clinical outcomes for patients undergoing arthroscopic rotator cuff repair with or without acromioplasty at short-term follow-up.

Keywords : Rotator cuff repair ; acromion ; acromioplasty ; subacromial decompression ; functional outcomes.

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INTRODUCTION

Since Neer *(25)* and Bigliani *(4)* reported the role of anterior acromioplasty for chronic impingement syndrome, many authors demonstrated consistent satisfactory outcomes after acromioplasty for the treatment of various rotator cuff tears and impingement syndrome *(5,11)*. The possible benefits of acromioplasty for rotator cuff repair are based on the theory of extrinsic subacromial impingement that acromial morphology is the initial factor contributing to abrasion of the rotator cuff and eventual rupture *(3,4)*. Subacromial decompression as described by Ellman *(9)*, including bursectomy, coracoacromial ligament release, and anterior-inferior acromioplasty, is believed to relieve extrinsic, primary impingement by increasing the height of subacromial space *(27)*. Therefore, subacromial decompression has become the mainstay of surgical treatment for rotator cuff disorders.

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However, the superiority of subacromial decompression, especially acromioplasty is still under debate, although the incidence of acromioplasty during arthroscopic rotator cuff repair has significantly increased recently *(33,34)*. The potential disadvantages of subacromial decompression include weakening of the deltoid origin and acromioclavicular joint, anterosuperior instability of the glenohumeral joint, and the formation of adhesions between the undersurface of acromion and rotator cuff that may limit range of motion *(12)*. Furthermore, several studies have confirmed that rotator cuff tears are caused by aging and intrinsic overloading rather than the extrinsic impingement *(6,29)*.

The purpose of this study was to perform a systematic review and meta-analysis of all available level I and II randomized controlled trials comparing the outcomes of patients undergoing arthroscopic repair of full-thickness rotator cuff tears with or without acromioplasty. We hypothesized that there would be no significant difference between acromioplasty and nonacromioplasty groups in terms of clinical outcomes.

MATERIALS AND METHODS

The systematic review and meta-analysis was conducted following the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) statement *(22)*. We performed a literature search with the search terms "acromioplasty," "subacromial decompression," and "rotator cuff" with the limits "randomized controlled trials" using PubMed (1950 to January 2015), Embase (1978 to January 2015), the Cochrane Central Register of Controlled Trials (up to January 2015), and Web of Science (1977 to January 2015). All of the retrieved articles were screened for potential studies. When necessary, the authors were contacted for a complete manuscript or data confirmation.

All randomized and quasi-randomized controlled trials (level I and II studies) that compared the clinical outcomes of patients undergoing arthroscopic repair of full-thickness rotator cuff tears with or without acromioplasty were included.

Types of participants

Patients aged 18 years or older who were diagnosed with a full-thickness tear of at least 1 rotator cuff tendon were eligible for inclusion.

The primary outcome of interest was a commonly used functional score for rotator cuff disease, American Shoulder and Elbow Surgeons (ASES) score *(20)*. The secondary outcomes of interest were the other functional scores, including University of California-Los Angeles (UCLA) score *(2)* and Constant-Murley (CM) score *(8)*. Visual analog scale (VAS) for pain and reoperation rate were also included in the outcomes of interest.

Two reviewers (Z. Sun and W. Fu) independently evaluated each of the relevant studies for eligibility for full review on the basis of titles and abstracts. Disagreement was resolved by discussion and consensus. The reviewers were not blinded to the titles of journals or the names of authors of any evaluated studies.

Two researchers separately extracted data, and the data were pooled for a meta-analysis. In terms of data abstraction, it included study characteristics, patient demographics, tear size, acromion type, procedure details, and functional outcomes. All the extracted data were pooled for statistical analysis with the use of RevMan software 5.3 (Cochrane Collaboration, London, UK, 2014).

For continuous outcomes (ie, ASES, VAS), the mean difference (MD) with 95% confidence intervals (CI) was calculated. For binary variables (ie, reoperation rate), the relative treatment effect was reported as a risk ratio (RR) with 95% CI. The degree of heterogeneity was investigated with the Cochrane $\chi 2$ test and quantified with the I2 statistic. An I2 of less than 50% was the cutoff for homogeneity of the data using a fixed-effects model, justifying pooling. Otherwise, a random effects model was applied if I2 of more than 50% and heterogeneity was significant. Results for all analyses were considered significant at P values < 0.05.

RESULTS

The process for the search strategy was summarized in Figure 1. The literature search produced a total of 342 titles and abstracts including duplicates. After initial screening and exclusion of duplicates, 207 studies were eliminated. After examining the titles and abstracts, 116 studies were considered to not meet the inclusion criteria. Finally, we identified 5 recently published randomized trials *(1,10,17,21,30)*, 3 level I and 2 level II, that met the prespecified inclusion criteria. A total of 5 randomized trials were included in the meta-analysis.

Table I presents the patient demographics and baseline characteristics. Table II summarizes the characteristics of individual studies and outcomes. In total, 465 patients were extracted from the included studies, of whom 277 (59.6%) were men. The mean age across all of the trials ranged from 56.8 to 60.3 years. The mean follow-up period was between 15.6 and 35 months, and the follow-up rate ranged from 79.1% to 100%.

ASES score was reported in 4 studies *(1,10, 17,30)*. Pooled analysis presented no statistically significant difference in patients treated with or without acromioplasty (MD, 1.92; 95%CI, -0.85 to 4.70; P = 0.17) and no heterogeneity (P = 0.39, I2 = 0%) (Fig 2). Three studies reported the outcomes of CM score *(1,21,30)*. Pooled analysis revealed that the CM score of patients treated with subacromial decompression was higher than those without it in favor of performing subacromial decompression (MD, 3.12; 95%CI, -0.05 to 6.29; P = 0.05) (Fig 3). However, this difference did not reach the significant level (P =0 .05) and was not likely to be clinical significance. There was no statistically significant heterogeneity (P = 0.50, I2 = 0%). Two clinical trials *(1,30)* were reviewed for UCLA score.

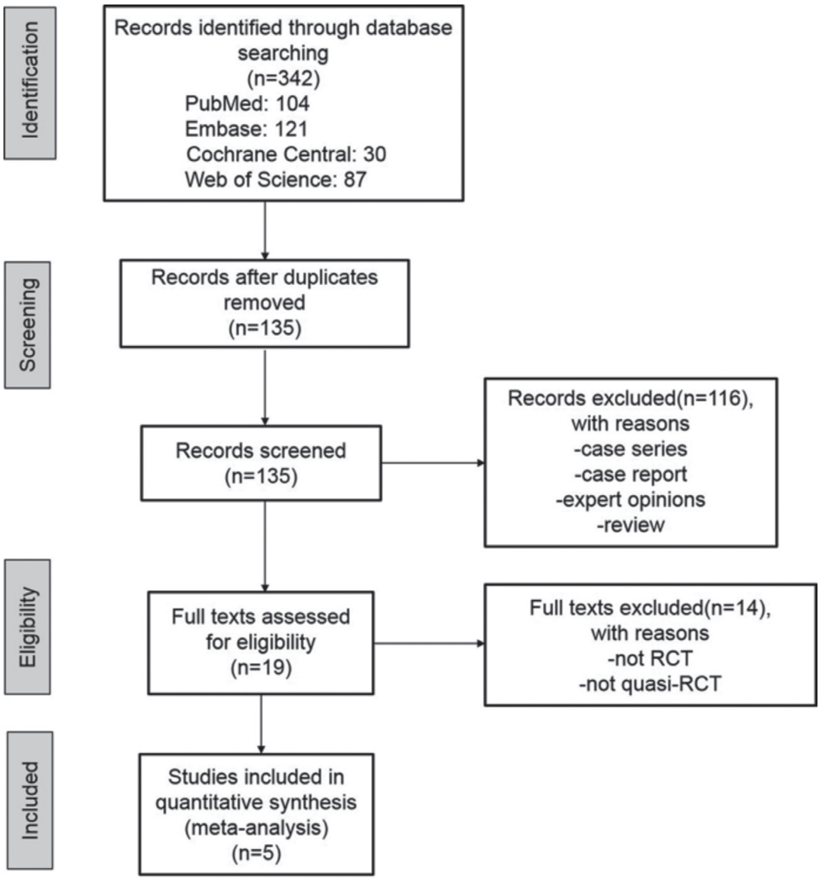

Fig. 1. — Flow chart shows how articles were selected. RCT, randomized controlled trial

Table I . — Characteristics of included studies

Author	Setting	Mean age (years)	Sample size (% male)	Effective follow-up (%)	Mean follow-up (months)	Evidence level
Gartsman et al. 2004 [10]	United States	59.7	93 (55)	100	15.6	I
Milano et al. 2007 [21]	Italy	60.3	71 (55)	88.8	24	I
MacDonald et al. 2011 [17]	Canada	56.8	86 (65)	79.1	24	I
Shin et al. 2012 [30]	South Korea	56.8	120 (56)	80	35	II
Abrams et al. 2014 [1]	United States	59.2	95 (67)	83.3	24	II

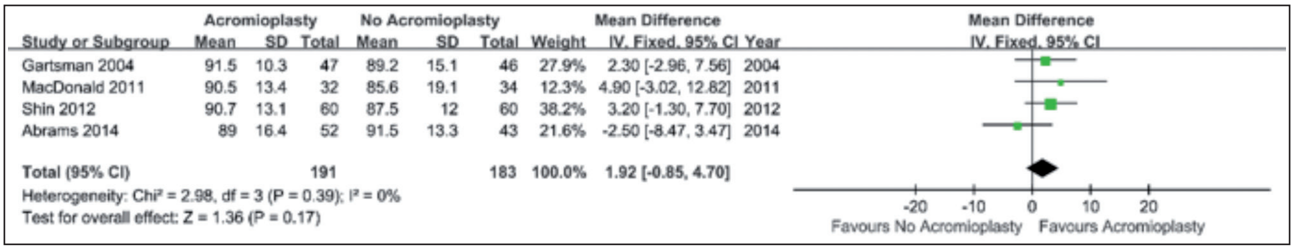

Fig. 2. — Forest plot of MD with 95% CI for ASES score

The meta-analysis yielded similar result between the two groups (MD, 0.70; 95%CI, -0.21 to 1.60; P=0.13) with no heterogeneity detected (P = 0.33, I2 = 0%) (Fig 4).

VAS for pain was documented in 2 studies (1, 30). Pooled analysis demonstrated no significant difference between the two groups (MD, 0.01; 95%CI, -0.48 to 0.49; P = 0.98) (Fig 5). A fixed effects model was used to pool data because the degree of heterogeneity was acceptable (P = 0.17, I2 = 46%).

Reoperation rate

Of the 5 included studies, 3 trials described the rate of reoperation *(1,17,30).* Pooled results indicated that the total reoperation rate was not significantly different between the two treatment groups (RR, 0.51; 95%CI, 0.05 to 5.29; P = 0.57) with heterogeneity detected (P = 0.10, I2 = 57%) (Fig 6).

Other clinical outcomes including the DASH, Work-DASH, WORC index, SST score, and range of motion were not included in the mate-analysis. These outcomes of interest were documented only in individual articles, therefore we could not pool data and make significant comparisons.

DISCUSSION

The results of this investigation showed that there would be no statistically significant difference in patients treated with or without acromioplasty after arthroscopic repair of full-thickness rotator cuff tears with regard to the short-term functional outcomes and reoperation rate.

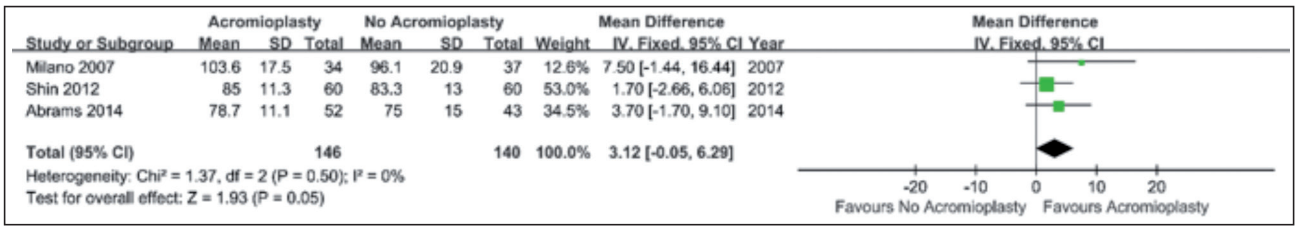

Fig. 3. — Forest plot of MD with 95% CI for CM score

Details of surgery*

Table II. — Summary of individual study characteristics and outcomes

Source	Inclusion criteria	Tear size	Acromion type (n)	Interventions*	Details of surgery‡	Outcomes§
Gartsman et al. 2004 [10]	1. Isolated, repairable full-thickness supraspinatus tendon tear 2. Type II acromion	Mean length: 21.3 mm Mean width: 8.8 mm	II, 93	ARCR-SD vs ARCR	RC: SR	ASES
Milano et al. 2007 [21]	1. Repairable full-thickness RC tear 2. Type II or III acromion	Mean area: 376.1 mm²	II, 48 III, 23	ARCR-SD vs ARCR	RC: TTB, STS, combined repair technique Biceps tendon: BD, BT	CM, DASH, Work-DASH
MacDonald et al. 2011 [17]	1. Full-thickness RC tear ≤4 cm of one or more tendons 2. Age ≥18 years	Tear ≤4 cm	I, 12 II, 50 III, 20	ARCR-A vs ARCR	RC: SR	WORC, ASES
Shin et al. 2012 [30]	Small- to medium-sized rotator cuff tears	Mean size: 15.0 mm	I, 33 II, 68 III, 19	ARCR-A vs ARCR	RC: SR or DR Biceps tendon: BD, BT	ASES, UCLA, CM, VAS, ROM (FF, ER, IR)
Abrams et al. 2014 [1]	1. Full-thickness superior RC tear	Mean size: 25.8 mm	I, 10 II, 57	ARCR-A vs ARCR	RC: SR, DR, STS Biceps tendon: BD, BT	ASES, SST, UCLA, CM, VAS
‡	2. Age ≥18 years	‡	III, 19	‡	Distal clavicle excision	‡

* ARCR arthroscopic rotator cuff repair, ARCR-SD arthroscopic rotator cuff repair with subacromial decompression, ARCR-A arthroscopic rotator cuff repair with acromioplasty

‡ RC rotator cuff, SR single row, DR double row, TTB tendon-to-bone, STS side-to-side, BD biceps debridement, BT biceps tenodesis or tenotomy

§ASES American Shoulder and Elbow Surgeons score, CM Constant-Murley score, DASH Disabilities of the Arm, Shoulder and Hand questionnaire, WORC Western Ontario Rotator Cuff index, UCLA University of California-Los Angeles score, SST Simple Shoulder Test score, VAS visual analog scale for pain, ROM range of motion, FF forward flexion, ER external rotation, IR internal rotation

Currently, there is no consensus about whether rotator cuff tears arise from intrinsic degeneration *(14)* or extrinsic impingement *(26)*. The pathogenesis of degenerative rotator cuff disease is multifactorial and remains controversial. Among these factors, the quantitative anatomic variants of scapula appears to be associated with the presence of rotator cuff tears. Many authors have suggested that a hooked acromion, a flatter slope of the acromion, as well as with a decreased lateral acromial angle may reduce the subacromial space, thereby increasing the pressure on the rotator cuff and progressive tearing during the past decades. In 2006, Nyffeler et al. introduced the acromion index (AI) to quantify the lateral extension of the acromion. They postulated that a high AI results in a more vertical orientation of the middle deltoid, necessitating the rotator cuff to exert a higher horizontal force to maintain the center of rotation. They also concluded that a high acromion index appeared to be associated with full-thickness tearing of the rotator cuff *(28)*. However, the index does not account for the tilt of glenoid fossa, which is an imperative prediction of the occurrence of rotator cuff disease *(15)*. In 2013, Moor et al. introduced the concept of the critical shoulder angle (CSA) that combines the acromion acromion and glenoid inclination, integrating both potential risk factors into one radiologic parameter.

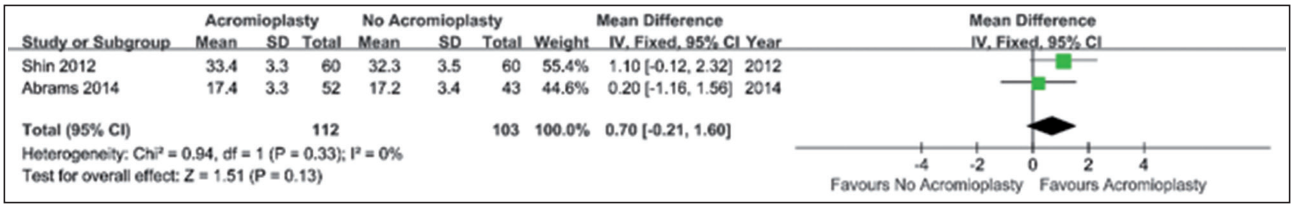

Fig. 4. — Forest plot of MD with 95% CI for UCLA score

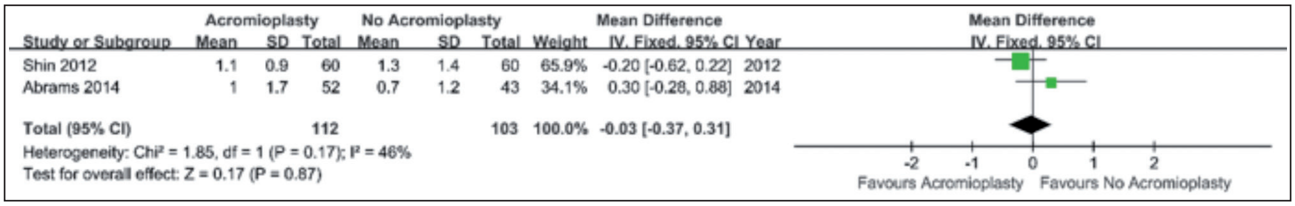

Fig. 5. — Forest plot of MD with 95% CI for VAS for pain

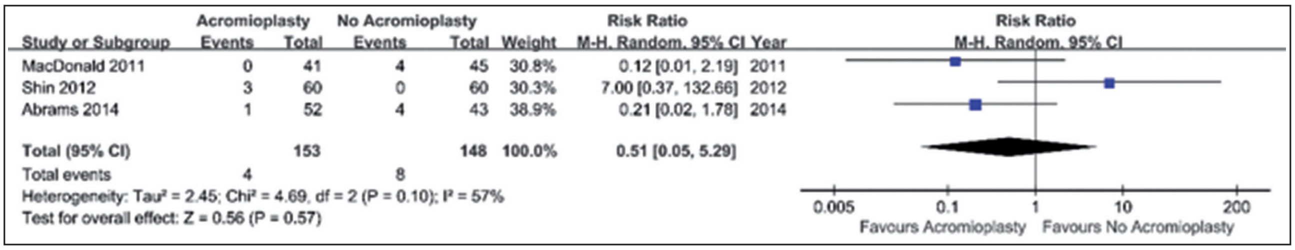

Fig. 6. — Forest plot of RR with 95% CI for the reoperation rate

They demonstrated that CSA was significantly smaller in primary glenohumeral osteoarthritis and larger in degenerative rotator cuff tears compared with normal shouders *(23)*. More recently, Moor et al. found that the acromion index, lateral acromion angle, and critical shoulder angle were the accurate predictions in individuals suffering from degenerative rotator cuff tears. In contrast, neither the association between rotator cuff tears and acromion morphology nor the relationship of rotator cuff disease with acromial slope could be confirmed *(24)*.

Several authors have found a significant increase in superior translation of the humeral head with subacromial decompression *(31)*. Thus, shoulder surgeons tend to focus more on the role of the coracoacromial arch in the maintenance of the stability of glenohumeral joint and deltoid muscle function and strength *(16)*. Furthermore, the efficacy of acromioplasty remains controversial as to whether it can protect the rotator cuff from undergoing further degeneration *(16)*. Recently, many studies have presented good to excellent outcomes after rotator cuff repair without acromioplasty *(7,13,19)*. McCallister et al. *(19)* reported that a significant improvement in shoulder comfort and function could be achieved after repair of full-thickness rotator cuff tears without acromioplasty at least 2 years postoperatively. Other authors *(7)* reported that there were 79% excellent or good results in patients undergoing arthroscopic debridement for partial-thickness rotator cuff tears with a mean 9.5 years follow-up. The findings might support the notion that rotator cuff repair could be sufficient in patients diagnosed with rotator cuff tears.

The findings of our meta-analysis are consistent with previous reports *(1,10,17,21,30)*. Abrams et al. *(1)* demonstrated that there was no significant difference in functional scores after arthroscopic rotator cuff repair with or without concomitant acromioplasty. The patients undergoing revision surgery were 4 (9.3%) in the nonacromioplasty group and 1 (1.9%) in the acromioplasty groups with no significant difference detected. Recently, MacDonald et al. *(17)* proved that no difference was found in WORC index and ASES score for patients treated with or without acromioplasty. Furthermore, they also did not find any interaction effects between functional outcomes and acromial morphologic type either within or between groups. However, the proportion of patients without acromioplasty who had a reoperation was found to be greater (P = 0.05) than that in the study group, in which no reoperation occurred. Additionally, other authors still did not show significantly different in functional scores between the two treatment groups *(10,21,30)*. Therefore, although many factors are associated with the etiology of rotator cuff tears in nature, additional acromioplasty with arthroscopic rotator cuff repair does not improve clinical outcomes for patients with full-thickness rotator cuff tears.

One of the strengths of this study is that it presents the most comprehensive, stringent review that analyzes the efficacy of acromioplasty in patients diagnosed with full-thickness rotator cuff tears. Another strength is that all of the included studies have used adequate randomized allocation and allocation concealment methods. This helps to limit bias and increase reliability of the conclusions. Finally, the generalizability of the results in our study is reliable because the demographics of our research are very common in epidemiologic studies on the prevalence of rotator cuff tears in the general population *(18,32)*.

There are several limitations to this study. First, the mean follow-up period ranged from 15.6 to 35 months, which was relatively short to effectively corroborate the clinical outcomes. Next, there were different variables included in the study group: demographics, surgical techniques, outcome measurements, postoperative rehabilitations and follow-up periods, which could make the results ambiguous. Furthermore, only 1 of the 5 included studies *(30)* reported the healing rate of rotator cuff, which made it impossible to pool data. Further study that includes follow-up imaging and the healing rate over an extended period is needed. Finally, the outcome metrics of the included studies may not be sensitive enough to detect subtle differences between functional scores and acromion type. Long-term follow-up with stratification for acromion type is needed *(13)*.

CONCLUSION

Despite a higher CM score in acromioplasty group, the current study did not demonstrate any significant difference in ASES score, UCLA score, VAS for pain, and reoperation rate after arthroscopic repair of full-thickness rotator cuff tears with or without acromioplasty at short-term follow-up. Thus, we do not recommend the routine use of acromioplasty as an adjunct to arthroscopic rotator cuff repair. Longer-term follow-up studies are required to focus on patient-reported outcome measures, imaging-diagnosed re-tears, and the effect of acromial morphology on the rate of reoperation.

Conflicts of interest:
The author, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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