



Research article

Imaging evaluation of disc position and status after temporomandibular joint arthroscopic disc repositioning and suturing surgery

Zixian Jiao ^{a,1}, Siyu Wu ^{a,1}, Jiayi Li ^a, Pei Shen ^a, Chi Yang ^{b,c,d,e,f,*}

^a Department of Oral Surgery, Shanghai Ninth People's Hospital, Shanghai Jiaotong University School of Medicine, Shanghai, PR China

^b Department of Oral Surgery, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, PR China

^c College of Stomatology, Shanghai Jiao Tong University, Shanghai, PR China

^d National Center for Stomatology, Shanghai, PR China

^e National Clinical Research Center for Oral Diseases, Shanghai, PR China

^f Shanghai Key Laboratory of Stomatology, Shanghai, PR China

ARTICLE INFO

Keywords:

Anterior disc displacement
temporomandibular joint
Arthroscopic disc repositioning
Over-correction

ABSTRACT

Objective: This study aimed to explain the change of disc position at different over-corrected place after arthroscopic disc repositioning and suturing surgery.

Study design: Patients treated with temporomandibular joint arthroscopic disc repositioning and suturing surgery were reviewed. All patients underwent magnetic resonance imaging (MRI) before, immediately after surgery and at 2-year follow-up. The position of disc was checked and the change was compared.

Results: 133 patients were included in the final analysis with 203 TMJ sides. The incidence rate for anterior movement of the disc after surgery was 33.0 %. Disc repositioned between 12 and 1 o'clock showed smaller movement rate of 22.6 %, while higher movement rate of 53.6 % was seen when repositioned between 2 and 3 o'clock.

Conclusions: After arthroscopic disc repositioning and suturing surgery for ADD patients, the repositioned disc showed tendency to move forward. 12 to 1 o'clock was optional disc site for repositioning while excessive over-correction was not recommended.

1. Introduction

Anterior disc displacement (ADD) is the most prevalent form of temporomandibular joint disorder (TMD) [1] that often results in complains including joint pain, clicking and functional limitations [2]. Temporomandibular joint (TMJ) disc repositioning surgery has been applied for a long time and is recommended if a period of conservative treatment shows no improvement of symptoms [3–5]. The arthroscopic approach has been reported to be a reliable treatment option for ADD and has satisfying outcome concerning faster clinical recovery and better condylar remodeling compared to open procedure [6].

If the disc was positioned to an anatomically ideal place, a relapse in disc position would occur at an undetermined time following

* Corresponding author. Department of Oral Surgery, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, PR China.

E-mail address: yangchi63@hotmail.com (C. Yang).

¹ These authors contributed equally to this work and should be considered co-first authors.

<https://doi.org/10.1016/j.heliyon.2024.e25526>

Received 22 August 2023; Received in revised form 26 January 2024; Accepted 29 January 2024

Available online 30 January 2024

2405-8440/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

surgery [7], thereby over-correction of the disc was performed to avoid relapse. However, even an over-correction to the 1 to 2 o'clock is designed in open disc reposition surgery, 4.7 % of discs relapsed anteriorly [8]. In addition, no quantitative study has reported the optimal over-correction position of the disc. Thus, we assume that relapse is also related to the degree of over-correction.

Researchers have found that shortening of disc length and decrease of disc volume were observed in ADD, while after disc repositioning surgery, the disc was recovered both in length and in volume [9,10]. In clinical practice of the author's department, it has been noticed that besides the shape of the disc, the position of the disc changed gradually after repositioning surgery. We believe that the position of the disc is not strictly fixed but shall change. However, no previously reported study has compared the position of disc to confirm such tendency.

The purpose of this retrospective study was to evaluate the change in disc position after arthroscopic disc repositioning and suturing surgery in ADD patients and to verify the most stable degree of over-correction.

2. Materials and methods

2.1. Patients

This retrospective study protocol was approved by the independent Ethics Committee of the 9th People's Hospital Affiliated to Shanghai Jiao Tong University School of Medicine (SH9H-2022-T406-1), and is in compliance with the Helsinki Declaration. All patients have provided written informed consent.

The patients included in this retrospective study were collected from a consecutive series of patients admitted to Department of Oral Surgery in Shanghai Ninth People's Hospital affiliated to Shanghai Jiao Tong University School of Medicine. The inclusion criteria were: 1) visited our clinic between 2018 and 2020 without restriction of sex and age; 2) the participants included in the present study were diagnosed with stage 0 to stage 3A according to Yang's classification of TMJ ADD on preoperative MRI [11]; 3) had no history of infection, facial trauma, or congenital and systematic disorders; 4) follow-up period was longer than 2 years and MRI were reviewed at 2-year post-operation. The exclusion criteria were as follows: 1) orthodontic or orthognathic treatment during the follow up period; 2) patients with recurrence of disc displacement after surgery found by MRI after follow-up; 3) with poor image quality of MRI; 4) did not undergo postoperative MRI.

2.2. Surgical technique

The arthroscopic disc repositioning and suturing surgeries were all performed by Dr. Chi Yang, as described in the previous report [12]. In short, patients were under local anesthesia. A 2.3 mm arthroscope with a 2.8 mm outer protective cannula was utilized (Stryker, San Jose, CA). After fully releasing the anterior attachment of the disc using coblation probe, the disc had horizontal suture with non-absorbable 2-0 polyester multifilament suture material at posterior margin of the disc. The suture was subsequently brought out via the transmeatal portal. A stabilizing splint was used for every patient after surgery.

2.3. Variable and measurement

All patients were evaluated by MRI examinations at pre-operation, immediate post-operative follow-up and 2-year follow-up. MRI scans were performed using a 1.5-T scanner (General Electric, Milwaukee, WI) with a bilateral 3-inch TMJ surface coil receivers. The

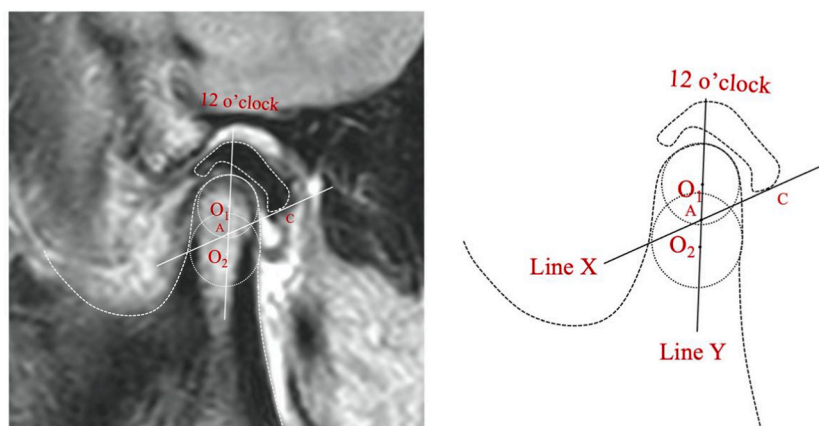


Fig. 1. Measurement of the position between the articular disc and the condylar process. First, the largest circle internally tangent to the outline of the anterior, posterior, and superior surfaces of the condylar head was drawn (O1). Then, an internally tangent circle, O2, was drawn at the most curved area between the condylar head and neck. The midpoint between two centers of O1 and O2 was defined as point A. Point C was the posterior point of the disc.

long axis of the condyle was found in the transection plane in a closed-mouth position using a T1-weighted spin echo sequence. The sagittal plane was then determined to be perpendicular to this long axis. The T1-weighted spin echo sequence in the sagittal plane in a closed-mouth position was scanned (TR: 500 ms, TE: 25 ms, 2 excitations, FOV: 12 cm, thickness 1 mm with a skip of 0.3 mm and a matrix of 512 × 256). The slice exhibiting the largest condylar diameter was chosen to mark the reference points of the joint structures.

Disc position: First, 2 circles were drawn. The largest circle (O1) was tangential to the outline of the anterior, posterior, and superior surfaces of the condylar head; another internally tangent circle O2 was at the most curved area between the condylar head and neck. Next, the long axis of the condylar head (line y) was defined as a line passing through the centers of O1 and O2 and was considered as the 12 o'clock position. The midpoint between two centers of O1 and O2 was defined as point A. Point C was the posterior point of the disc. A line connecting point A and point C was named line x, as shown in Fig. 1. The disc position of immediate post-operation was then divided into five groups according to the angle between line x and line y: 11 o'clock, 12 o'clock, 1 o'clock, 2 o'clock and 3 o'clock. While the disc position of 2 years post-operation was divided into six groups: 11 o'clock, 12 o'clock, 1 o'clock, 2 o'clock, 3 o'clock and 4 o'clock.

3. Result

After applying the inclusion and exclusion criteria, 133 patients with 203 joints were included in this study. As shown in Table 1, 67/203 (33.0 %) of the disc moved forwards after surgery in 2 years with a smaller portion (30/133, 22.6 %) when repositioned between 12 and 1 o'clock and higher portion (37/69, 53.6 %) when repositioned between 2 and 3 o'clock (Fig. 2A–C). Besides, 1 disc positioned at 1 o'clock and 2 discs positioned at 3 o'clock moved backwards (Fig. 3A–C).

4. Discussion

In the 1990s, McCain et al. [13] introduced an arthroscopic disc repositioning and suturing method for ADD patients. Their operation is to restore the disc in normal location with the posterior band in the 11 to 12 o'clock position and the success rate reached up to 81.8 % at 6-month post-operation. Subsequently, in terms of disc position, studies have reported the success rate of TMJ arthroscopy around 65 % at 1-year post-operation [14,15]. In the authors' department, Yang et al. [12] described a new arthroscopic disc repositioning and suturing technique, which positioned the disc slightly overcorrected, with a higher success rate of 98.1 % within 36 months postoperative [6]. However, the reposition distance showed small but insignificant change between the early and late postoperative visits [16], indicating the minor forward movement tendency of the disc after repositioning surgery.

As the disc position post-operation is correlated with clinical evaluation [17], Muñoz-Guerra et al. [18] reported that patients who took a second arthroscopy showed unsatisfactory results of both symptoms and disc position. Thus, we believe that maintaining the position of the disc after surgery is one of the key factors for reducing the symptoms of patients and promoting condyle regeneration. In present retrospective study, we first reported that the repositioned disc had slight forward movement due to functional compatibility, which verified the importance of over-correction. Also, we found that if the disc was placed at 12 to 1 o'clock, the disc had less tendency to move forward which suggested that the disc was more stable. Nevertheless, excessive over-correction would also cause instability of the disc position post-operation.

Our research showed that 67/203 (33.0 %) of the disc moved forwards after surgery in 2 years. The cause of disc displacement after operation is still unclear, however, it has been reported that both mechanical and anatomical factors might influence the stability outcomes of the disc repositioning surgery for ADD. For example, lateral pterygoid muscle did not cause disc displacement when the disc was intact, however it probably contributes to disc displacement when disc or joint pathosis already exists [19]. In terms of the surgery itself, arthrocentesis and postoperative inflammatory reaction may lead to inevitable swelling in the cavity and peripheral tissues, which will cause the condyle move forwards. When the swelling was completely absorbed, the position of the condyle will be restored and the real position of the disc would then be shown, which was likely to be little forward than that on the immediate postoperative MRI. In the authors' department, suture fixation to the anterior wall of the external auditory canal was used to achieve less traumatic effect. However, unlike nail-anchor, soft tissue allowability doesn't allow the effect as rigid internal fixation that keeps the disc still.

Besides, previous studies have shown that as joint space was significantly smaller in patients with ADD compared to normal disc [20], thus if the disc was repositioned at over-corrected place, the thickness of the disc could increase the space of the joint cavity. Instead, if the disc was repositioned at anatomical place, the joint space continued to be small as pre-operation state, which may cause

Table 1
Gradual Positional changes of repositioned disc.

Instant MRI					
Follow-up MRI	11 o'clock	12 o'clock	1 o'clock	2 o'clock	3 o'clock
11 o'clock	1	1	1	–	–
12 o'clock	–	19 (95.0 %)	28	1	–
1 o'clock	–	–	83 (73.5 %)	31	1
2 o'clock	–	–	1	25 (43.9 %)	4
3 o'clock	–	–	–	–	5 (41.7 %)
4 o'clock	–	–	–	–	2

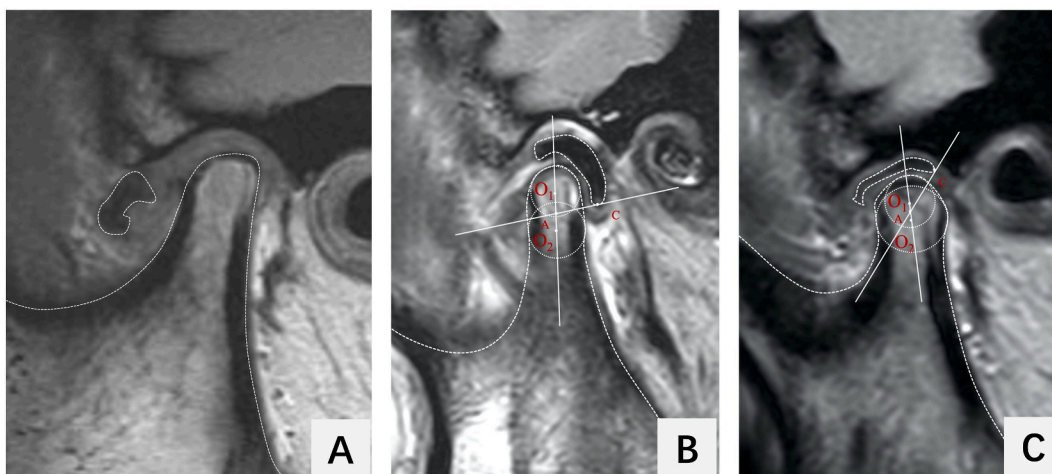


Fig. 2. A. Preoperative MRI showed TMJ ADD; B, Immediate postoperative MRI showed the articular disc reset at between the 2 and 3 o'clock direction and dilation of joint cavity; C, 18 months postoperative MRI showed the articular disc located between the 12 and 1 o'clock direction.

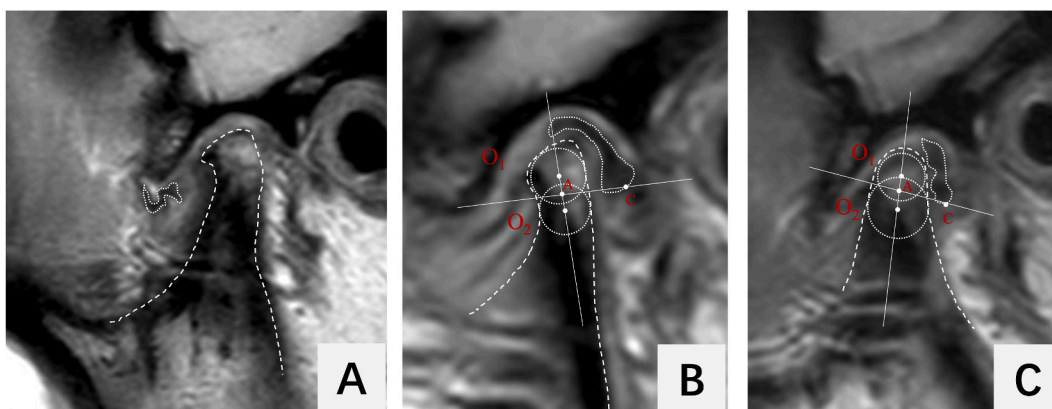


Fig. 3. A. Preoperative MRI showed TMJ ADD; B, Immediate postoperative MRI showed the articular disc reset at 3 o'clock direction; C, 16 months postoperative MRI showed the remodeling of the condyle and the articular disc located between 3 and 4 o'clock direction.

the stress on the joint to remain in a pathological state. Also, the repeated and excessive pulling forces from condylar motion during chewing and speech could generate a mechanical fatigue to the suture, especially those with nocturnal bruxism.

However, There are still limitations of the present study: 1) The sample size included in this study is relatively small; 2) As the sample size increases, age groups can be used to determine whether different remodeling abilities of the condyle have different effects on the position of the articular disc. 3) Prospective clinical studies can be designed to further analyze the factors affecting the stability of joint disc position.

5. Conclusion

After arthroscopic disc repositioning and suturing surgery for ADD patients, the change in repositioned disc position is common finding. The minor anterior or posterior movements of the disc is seen at any degree of over-correction. 12 to 1 o'clock was optional disc site for repositioning while excessive over-correction was not recommended.

Ethics statement

This retrospective study protocol was approved by the independent Ethics Committee of the 9th People's Hospital Affiliated to Shanghai Jiao Tong University School of Medicine (SH9H-2022-T406-1), and is in compliance with the Helsinki Declaration. All patients have provided written informed consent to have these images published.

Funding

This study was supported by Science and Technology Commission of Shanghai Municipality Science Research Project (21DZ2290500), National Key Research and Development Program of China, (2023YFC2509100)

CRediT authorship contribution statement

Zixian Jiao: Writing – original draft. **Siyu Wu:** Writing – original draft. **Jiayi Li:** Data curation. **Pei Shen:** Data curation. **Chi Yang:** Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- [1] L.F. Valesan, et al., Prevalence of temporomandibular joint disorders: a systematic review and meta-analysis, *Clin. Oral Invest.* 25 (2) (2021) 441–453.
- [2] S.J. Scriver, D.A. Keith, L.B. Kaban, Temporomandibular disorders, *N. Engl. J. Med.* 359 (25) (2008) 2693–2705.
- [3] Guidelines for diagnosis and management of disorders involving the temporomandibular joint and related musculoskeletal structures, *Cranio* 21 (1) (2003) 68–76.
- [4] S. Abramowicz, M.F. Dolwick, 20-year follow-up study of disc repositioning surgery for temporomandibular joint internal derangement, *J. Oral Maxillofac. Surg.* 68 (2) (2010) 239–242.
- [5] W.L. McCarty, W.B. Farrar, Surgery for internal derangements of the temporomandibular joint, *J. Prosthet. Dent* 42 (2) (1979) 191–196.
- [6] A. Abdelrehem, et al., Arthroscopic versus open disc repositioning and suturing techniques for the treatment of temporomandibular joint anterior disc displacement: 3-year follow-up study, *Int. J. Oral Maxillofac. Surg.* 50 (10) (2021) 1351–1360.
- [7] M.T. Montgomery, et al., Changes in signs and symptoms following temporomandibular joint disc repositioning surgery, *J. Oral Maxillofac. Surg.* 50 (4) (1992) 320–328.
- [8] Q. Zhou, et al., Modified temporomandibular joint disc repositioning with mini-screw anchor: Part II-stability evaluation by magnetic resonance imaging, *J. Oral Maxillofac. Surg.* 77 (2) (2019) 273–279.
- [9] Z. Liu, et al., The effect of arthroscopic disc repositioning on facial growth in juvenile patients with unilateral anterior disc displacement, *J. Cranio-Maxillo-Fac. Surg.* 48 (8) (2020) 765–771.
- [10] R. Wang, et al., Morphological changes of TMJ disc in surgically treated ADDwOr patients: a retrospective study, *BMC Oral Health* 22 (1) (2022) 432.
- [11] P. Shen, et al., Yang's classification of juvenile TMJ anterior disc displacement contributing to treatment protocols, *Sci. Rep.* 9 (1) (2019) 5644.
- [12] C. Yang, et al., New arthroscopic disc repositioning and suturing technique for treating an anteriorly displaced disc of the temporomandibular joint: part I-technique introduction, *Int. J. Oral Maxillofac. Surg.* 41 (9) (2012) 1058–1063.
- [13] J.P. McCain, A.E. Podrasky, N.A. Zabiegalski, Arthroscopic disc repositioning and suturing: a preliminary report, *J. Oral Maxillofac. Surg.* 50 (6) (1992) 568–579. ; discussion 579-80.
- [14] P.A. Silva, M.T. Lopes, F.S. Freire, A prospective study of 138 arthroscopies of the temporomandibular joint, *Braz J Otorhinolaryngol* 81 (4) (2015) 352–357.
- [15] R. Martín-Granizo, A. Millón-Cruz, Discopexy using resorbable pins in temporomandibular joint arthroscopy: clinical and magnetic resonance imaging medium-term results, *J. Cranio-Maxillo-Fac. Surg.* 44 (4) (2016) 479–486.
- [16] M.K. Sah, et al., Arthroscopic discopexy versus natural course of temporomandibular joint anterior disc displacement: a longitudinal study of clinical and radiological outcomes, *Int. J. Oral Maxillofac. Surg.* (2022).
- [17] G. Göçmen, et al., Evaluation of temporomandibular joint disc-repositioning surgery with Mitek mini anchors, *Natl. J. Maxillofac. Surg.* 4 (2) (2013) 188–192.
- [18] M.F. Muñoz-Guerra, et al., Modified arthroscopic anterior myotomy for internal derangement of the temporomandibular joint: clinical and radiological results, *Int. J. Oral Maxillofac. Surg.* 49 (10) (2020) 1311–1318.
- [19] S. Wongwatana, et al., Anatomic basis for disk displacement in temporomandibular joint (TMJ) dysfunction, *Am. J. Orthod. Dentofacial Orthop.* 105 (3) (1994) 257–264.
- [20] M.L.C. de Pontes, et al., Correlation between temporomandibular joint morphometric measurements and gender, disk position, and condylar position, *Oral Surg Oral Med Oral Pathol Oral Radiol* 128 (5) (2019) 538–542.