



**COSTOCHODRAL GRAFT WITH ABDOMINAL FAT AS
INTERPOSITINAL GRAFT VERSUS COSTOCHODRAL GRAFT
ALONE FOR RECONSTRUCTION OF TEMPOROMANDIBULAR
JOINT IN BILATERAL ANKYLOSIS IN ADULTS:
RANDOMIZED CONTROLLED CLINICAL TRIAL**

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ABSTRACT

Aim: The aim of this study was to evaluate the improvement of function and reduction of recurrence rate in patients with bilateral temporomandibular joint ankylosis treated with costochondral graft and interpositional fat compared to costochondral graft alone.

Materials and Methods: This was a randomized controlled trial conducted on 10 adult patients with bilateral TMJ ankylosis. In control group, TMJ reconstruction was performed with costochondral graft after gap arthroplasty. While in the intervention group, the same procedure was performed with the addition of autogenous abdominal fat graft as interposition material. All patients were followed up for at least 6 months. The primary outcome was the percentage of patients with reankylosis in each group. The secondary outcome was the change in maximal incisal opening (MIO) after 6 months.

Results: Both groups showed no recurrence. Intervention group showed lower change in the MIO (1.8 ± 0.84 mm) compared to the control group (2.4 ± 0.89 mm).

Conclusions: Interpositional abdominal fat with costochondral graft TMJ reconstruction for management of bilateral temporomandibular joint ankylosis was found to be beneficial with promising results regarding maintained gained range of mandibular function, with relapse avoidance. However with no evidence of recurrence in any of our cases and the non significant difference in MIO, its superiority over costochondral graft TMJ reconstruction has not been proved yet.

KEYWORDS: Temporomandibular ankylosis, Autogenous abdominal fat, costochondral graft.

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INTRODUCTION

Temporo-mandibular joint (TMJ) ankylosis is the limitation of mandibular movement as a result of either a fibrous, fibroosseous or bony union between the condyle of the mandible and the skull base^{1,2}. TMJ ankylosis has long been categorized according to site of the fusion into intra or extra articular ankylosis, type of tissue responsible of the union into osseous or fibrous ankylosis, extent of the fusion into complete or incomplete TMJ ankylosis, and according to the joints involved into unilateral or bilateral TMJ ankylosis^{3,4}.

This fusion results in hindrance of normal movement and function of the mandible, thereby interfering with nutrition, speech, airway patency, oral hygiene maintenance and growth of the mandible and even the facial bones. That said, TMJ ankylosis is not a sole functional disability but also an aesthetic one, with serious physical and psychological impact on the affected individuals^{1,5,6}. TMJ hypomobility and ankylosis are most commonly a result of trauma, local or systemic infections, systemic diseases as rheumatoid arthritis, ankylosing spondylitis and also psoriasis. Also it could be iatrogenic occurring after TMJ surgery^{1,3,7}.

The severity of facial disability returns to the age of the affected individual at the time of onset, the cause of the ankylosis, and the duration of the TMJ hypomobility⁸⁻¹⁰. Management of temporomandibular joint ankylosis aims to restore the joint function, improve the patient's appearance, life quality and to avoid recurrence or growth discrepancy^{2,3,9,11}. The ideal surgical technique to treat the affected individual is under a huge controversy. Techniques used for the management of TMJ ankylosis aims to creation of a gap between the fused bones (mandible and skull) and further prevention of reunion and creation of a new joint to restore function and aesthetics. This is achieved by several techniques as; gap arthroplasty, interpositional arthroplasty and joint reconstruction arthroplasty^{4,10,12,13}.

A diversity of autogenous grafts has been used in the reconstruction of the TMJ. Among them are the fibula, clavicle, sternoclavicular joint, iliac bone, metatarsal bone, metatarsal-phalangeal joint, and costochondral graft^{14,15,16}. Autogenous costochondral graft became popular for replacement of defective or missing mandibular condyles. It offers several advantages which include biological and anatomic similarity to the mandibular condyle, low morbidity of the donor site, ease of obtaining and adapting the graft and the regenerative potential in the growing individual. Costochondral graft provides the mandible with an active growth center in growing individuals, whereas while in adults it prevents jaw deviation or occurrence of an open bite specifically in the bilateral cases^{2,17,18}.

Autologous fat graft use in the TMJ for the treatment of ankylosis was first reported in 1913 by Blair¹⁹. Abdominal fat graft placement around the TMJ aims to prevent postsurgical heterotopic bone and fibrosis formation. The theory for utilizing autologous fat grafts was to obliterate the dead space among and around reconstructed joints, thereby hampering the formation and organization of blood clots, so creating a physical barrier that serves to minimize the presence of pluripotential cells, prevents the formation of extensive fibrosis and prevents heterotopic calcifications within and around the reconstructed joint²⁰.

This study aims to evaluate the improvement of function and reduction of recurrence rate in patients with bilateral temporomandibular joint ankylosis treated with costochondral graft and interpositional fat compared to costochondral graft alone.

PICO question

In adult patients with bilateral TMJ ankylosis, does using autogenous fat as interpositional material following TMJ reconstruction with costochondral graft will improve maximal incisal opening and decrease recurrence of ankylosis compared to TMJ reconstruction with costochondral graft alone?

MATERIALS AND METHODS

A. Trial design

This was a double-blinded, parallel-group randomized controlled clinical trial. Patients were allocated into 2 groups with allocation ratio 1:1. In control group, TMJ reconstruction was performed with costochondral graft after gap arthroplasty. While in the intervention group, the same procedure was performed with the addition of autogenous abdominal fat graft as interposition material.

B. Participants

This study was conducted on 10 patients selected from the out-patient clinic, Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Cairo University from January 2016 to December 2018. Patients were selected according to the following criteria: Adult patients with bilateral TMJ ankylosis; free from any systemic disease that may affect predictable outcome, or contraindicate the surgical procedure.

C. Interventions

All the patients were evaluated using clinical examination, computed tomography (CT) to confirm the diagnosis, and a detailed history was taken. Personal data, etiology, onset, duration, and maximum incisal opening (MIO) were recorded. Surgical procedures were performed under general anesthesia with nasal intubation. The surgical field was prepared in regular surgical manner. For all patients endaural, and submandibular incisions were performed bilaterally. Endaural incision was performed to access the joint, while the submandibular was performed for graft insertion and fixation (fig. 1). The bone mass was removed with burs and chisels to create a gap of about 1.5 cm. MIO was examined to assure an opening of 30 - 35 mm (fig. 2).



Fig. (1) The bone mass accessed via endaural incision.

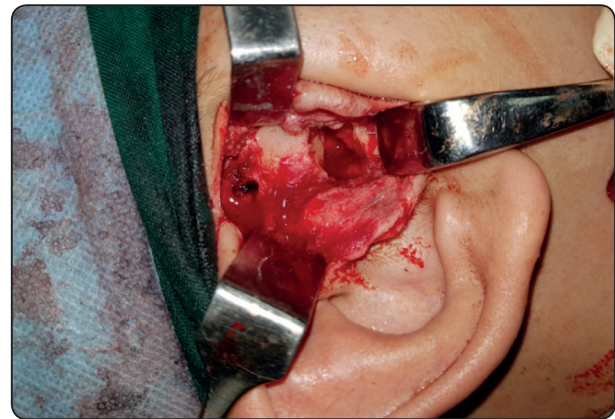


Fig. (2) The bone mass removed to create a gap of about 1.5 cm.

For the control group, the rib grafts were harvested from the fifth and seventh ribs. A skin incision was made on the sixth rib. The subcutaneous, fascial, and muscle layers were transected using electrocautery. The periosteum was incised till the costochondral junction, and perichondrium was preserved. Doyen rib retractor was used to strip soft tissues around the rib, and the graft was harvested with the cartilaginous cap (fig. 3). After graft harvesting and cartilaginous cap contouring, intermaxillary fixation (IMF) was performed with IMF screws, and the graft was fixed to the mandibular ramus with 3 screws (fig. 4, 5). Finally, the incision was sutured in layers. For intervention group, the graft was harvested and fixed to the ramus as in the control group. Abdominal fat graft was harvested. Vasoconstrictor as injected

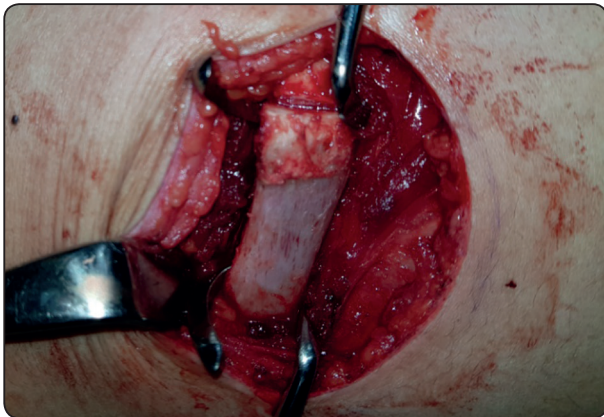


Fig. (3) Rib graft harvesting with the cartilaginous cap.

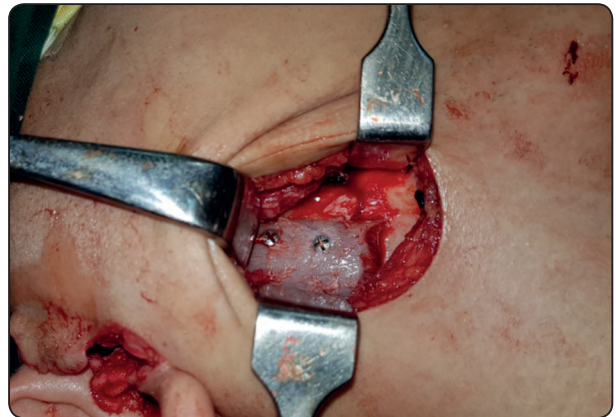


Fig. (4) The rib graft fixed to the mandibular ramus with 3 screws.

in the proposed site. Small midline skin transverse incision was performed about 3-5 cm below the umbilicus to expose the subcutaneous fat (fig. 6). The desired amount of graft was then harvested, and incision was sutured (fig. 7). The fat graft was then inserted in the new joint space, packed around the area, and sutured to the surrounding tissues (fig. 8). Finally, the incision was sutured in layers (fig. 9). Aggressive jaw exercise and intensive physiotherapy were started on the second day after surgery and continued for 3 months.

D. Outcomes

The primary end point of this study was the

recurrence of ankylosis. All patients were followed up for at least 6 months, and the percentage of patients with reankylosis was recorded in both groups. MIO was measured with a caliper in the following time points: preoperative (MIO_{pre}), immediate postoperative (MIO_0), 6 months postoperatively (MIO_6). The change in MIO after the surgery (MIO_{0-pre}) was calculated as the difference between preoperative and immediate postoperative MIO. The main end point of MIO assessment was the change in MIO after 6 months (MIO_{0-6}). It was calculated as the difference between 6 months postoperative MIO and immediate postoperative MIO. Finally, the percentage of the change in MIO

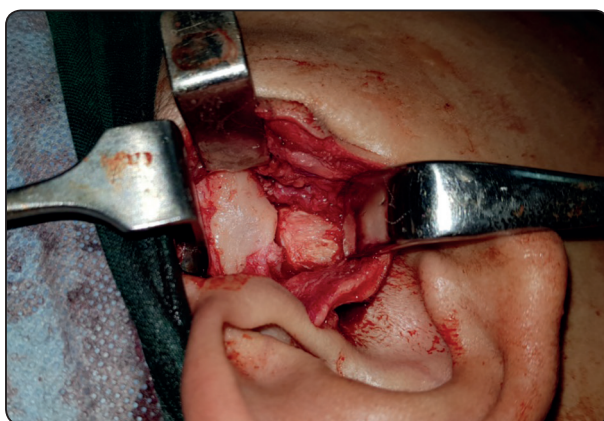


Fig. (5) TMJ rib graft in proper relation.

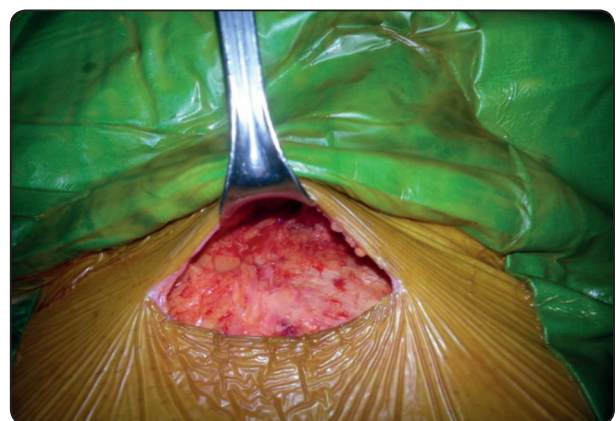


Fig. (6) Incision below the umbilicus to expose the subcutaneous fat.

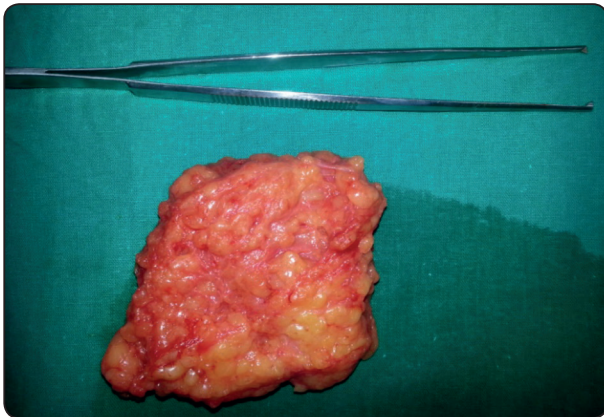


Fig. (7) Harvested abdominal fat.

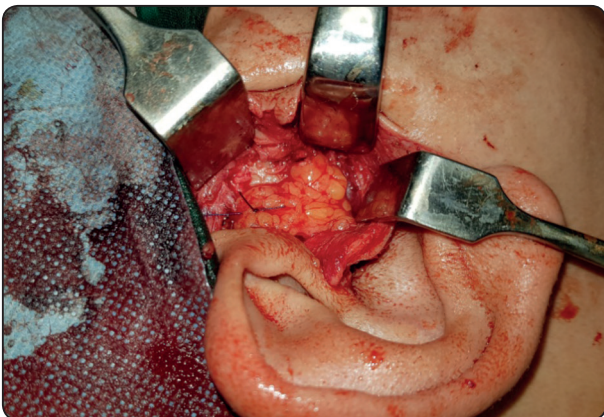


Fig. (8) Fat graft packed around the area, and sutured to the surrounding tissues.



Fig. (9) Incision was sutured in layers

was calculated as the change of MIO divided by the immediate postoperative MIO ($MIO_{0.6} / MIO_0$)

E. Randomization

Simple randomization was performed using 10 standardized paper sheets (5 for control group and 5 for intervention group) placed in sealed opaque envelopes. After accepting to be enrolled in the study, patients were assigned randomly to either group.

F. Blinding

In this study outcome assessor and statistical data analyst were kept blind to the technique used for each patient.

G. Statistical analysis

Statistical analysis was performed using SPSS (Statistical package for the social sciences- IBM® SPSS® Statistics Version 20 for Windows, IBM Corp., Armonk, NY, USA). Quantitative data were represented as mean \pm standard deviation, and Mann-Whitney U test was used to compare variables between the two groups. Qualitative data were represented as percentage or frequency, and Fisher's exact test was used to compare variables between the two groups. The results were considered statistically significant if the p value was less than 0.05.

RESULTS

This study was conducted on 10 patients (6 males, 4 females) with mean age of 26.6 ± 4.4 years. The mean age was 19.8 ± 1.9 years for the intervention group, and 21.4 ± 6.2 years for the control. No recurrence was observed in both groups. Maximal incisal opening was comparable in both groups in different time points. Intervention group showed lower loss and loss percentage of MIO after 6 months (1.8 ± 0.84 mm, 5.6 ± 2.5 %) compared to the control group (2.4 ± 0.89 mm, 7.9 ± 2.8 %). There was no statistically significance difference between the 2 groups (P value < 0.31) (table 1, fig. 10, 11, 12).

TABLE (1) Maximal incisal opening (Mean ± standard deviation)

	MIO _{pre}	MIO ₀	MIO _{0-pre}	MIO ₆	MIO ₀₋₆	MIO ₀₋₆ %
Intervention	3.8 ± 1.67	32.2 ± 2.28	28.4 ± 3.2	30.4 ± 2.3	1.8 ± 0.84	5.6 ± 2.5
Control	3.6 ± 1.14	30.2 ± 2.68	26.6 ± 2.4	27.8 ± 3.49	2.4 ± 0.89	7.9 ± 2.8

MIO_{pre} Maximal incisal opening preoperative, MIO₀ Maximal incisal opening immediate postoperative, MIO_{0-pre} Difference between preoperative and immediate postoperative maximal incisal opening, MIO₆ Maximal incisal opening 6 months postoperative, MIO₀₋₆ Difference between immediate postoperative and 6 months postoperative maximal incisal opening, MIO₀₋₆ % the percentage of the change in maximal incisal opening after 6 months.

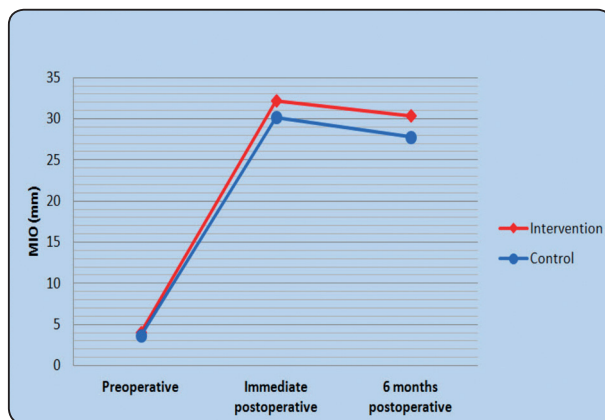


Fig. (10) Line graph showing MIO in both groups at different time points

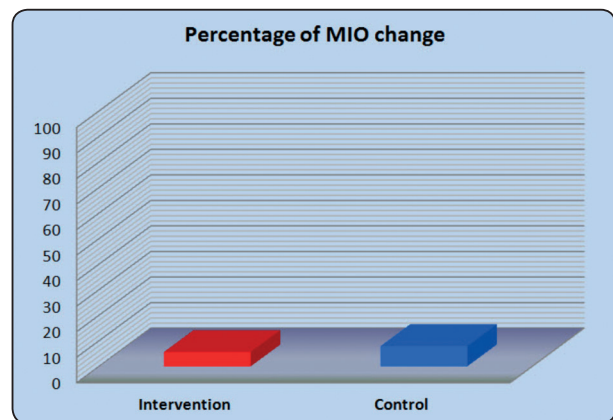


Fig. (12) Bar chart showing percentage of change in MIO after 6 months in both groups.

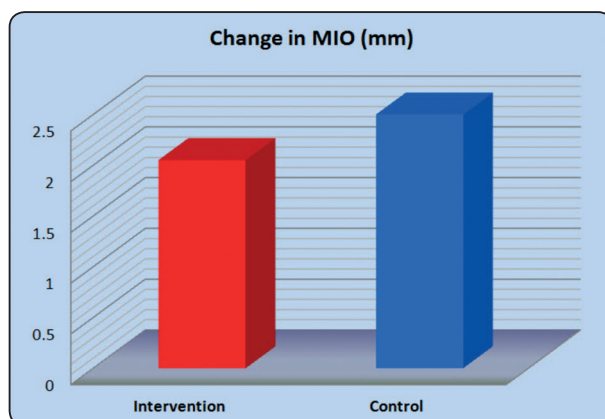


Fig. (11) Bar chart showing change in MIO after 6 months (MIO₀₋₆) in both groups.

DISCUSSION

TMJ ankylosis is one of the most upsetting conditions that cause many problems to the affected individuals²¹. Many procedures have been proposed for the treatment of such condition including condylectomy, gap arthroplasty, and interpositional gap arthroplasty with or without TMJ reconstruction. A lot of materials had been used as an interposition graft with variable rate of success²². Interpositional graft has been introduced by Esmarch in the 19th century²³. Interpositional grafts should fulfill the following criteria: it should be cost effective, avoid esthetic drawbacks at the donor site, tolerate and adapt to masticatory forces, low risk of infection, obliterate the created dead space, and guard against heterotopic bone formation and thus reankylosis.²⁴

Free fat graft was found to fulfill most of the previous criteria and was used in multiple studies involving TMJ surgeries²⁵. In 1957, Georgiade introduced abdominal free fat graft as an interpositional material in TMJ ankylosis²⁶. Since then, it has been used following total joint reconstruction, gap arthroplasties, discectomies and disc anchor²⁷⁻²⁹. It helps to fill the dead space in the created gap and aids in hemostasis, preventing hematoma formation. This will decrease scar tissue formation, incidence of fibrosis and heterotopic bone formation, thus preventing reankylosis and increasing the range of motion^{30, 31}. Moreover, fat graft can be easily placed into cavities of any size. As the donor site is primarily sutured, and the scar is hidden under the belt line, morbidity of this region is not an issue³². A pioneer study evaluating fat grafts placed around TMJ total joint prosthesis stated significant reduction in pain and no radiographic or clinical evidence of heterotopic calcifications were apparent in any of the patients in which fat graft was used. Thus concluding that autologous fat transplantation as an adjunctive to TMJ reconstruction will minimize post-operative joint fibrosis and heterotopic calcifications.⁽²⁸⁾

Even though abdominal fat may undergo variable degree of resorption after loading, Dimitroulis et al claimed that there is no significant change in the size of the grafted fat in TMJ surgeries with time³³. Tekin et al used abdominal free fat graft following the removal of failed TMJ prosthesis and he claimed that Long-term CT scans (average, 4 years post surgery) revealed fat graft retention in the wide gap between the glenoid fossa and the ramus³⁴.

The therapeutic algorithm presented in the current study offers favorable morphological and functional outcomes, however both early and aggressive functional physiotherapy is crucial to minimize the ongoing risk of relapse and recurrence of the TMJ ankylosis³⁵. The goals of the surgical procedure for the management of the cases were to release the ankylotic bony mass, improve mandibular range of motion, improve esthetics and prevent reankylosis.

The 3 principal surgical procedures include gap arthroplasty, followed by costo chondral joint reconstruction with interpositional fat graft³⁶.

Utilizing autogenous costochondral grafts for reconstruction of the temporomandibular joint was first introduced by Gillies in the 1920s. Studies have stated that costochondral grafts were proven to be the best option among the donor autogenous tissues used for reconstruction of the condyle. The main reason for its superiority is the similarity of the costochondral graft to the mandibular condyle and its capability to grow and regenerate³⁷. Moreover, costochondral graft showed greater MIO when compared to alloplastic joint reconstruction³⁸.

In the current study, costochondral graft reconstruction was performed after gap arthroplasty in the control group as the standard care. While in the intervention group abdominal fat was used as interpositional material with costochondral graft in a trial to decrease recurrence and improve MIO. Both groups showed comparable recurrence rate (0%) after 6 months. This result failed to prove the superiority of interpositional fat with costochondral graft over costochondral graft. The secondary objective of this study was to assess whether interpositional fat will improve MIO or not. Fat group (intervention group) showed higher MIO compared to the control group, but there was no significant difference between the two groups. Interpositional abdominal fat with costochondral graft showed promising results, but it was comparable to that of costochondral graft. The main limitation of our study was the small sample size. This was attributed to the availability of patients fulfilling our eligibility criteria for such randomized controlled trial.

CONCLUSIONS

Interpositional abdominal fat with costochondral graft TMJ reconstruction for management of bilateral temporomandibular joint ankylosis was found to be beneficial with promising results regarding maintained gained range of mandibular function, with relapse avoidance. However with no evidence

of recurrence in any of our cases and the non significant difference in MIO, its superiority over costochondral graft TMJ reconstruction has not been proved yet. We recommend conduction of more randomized controlled trials with larger sample size (and higher power) for further evaluation of the benefits of the use of fat in the TMJ reconstruction cases and for long term assessments based on the promising short term reported outcomes.

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