Histological Evaluation Of The Temporomandibular Joint After Mandibular Osteodistraction And Mandibular Advancement Osteotomy

Mohamed A. Katamish [1], Awatef Abdul- Hamid Mady[2]

[1]Lecturer of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ain Shams University.
[2]Researcher in Research centre & Bilharzias Researches, Faculty of medicine, Ain shams university
Corresponding author: E-mail: Katamish72@yahoo.com

Abstract: ***Objectives*****:** Is to compare between histological results of the temporomandibular joint after mandibular advancement versus distraction osteogenesis. ***Materials and methods*****:** Sample of the study was 21 adult male goats, the animals were divided into 3groups (9 animals in each); group A(two surgical groups (Distraction group), group B (Orthognathic group), and group C (control group which contained 3 animals). In group A especial design distraction device was applied extra-orally after osteotomy at right angle of mandible. While in group B Unilateral Sagittal Split Osteotomy with mandibular advancement and screws fixation was done. In the third group scarification of the animal. Histological evaluation using stained sections with Heamatoxylin Eosin (H&E).***Results*****:** There were a variations in structures of the joint in each group and at each week. Most of these variations were in thickness of the fibrocartilagenous layer of the temporal bone, number of multinucleated giant cells, chondrocytes that form the articulating disc. No signs of bone denudation or erosion were observed. ***Conclusions*****:** The gradual lengthening of the mandible through distraction osteogenesis have smooth effects on the joint, but finally after a sufficient time both distraction and sagittal split osteotomy showed the same results.

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1. Introduction

Dentofacial malformation is accompanied by many functional and esthetic problems. Impairment of dental health by increasing susceptibility to caries, periodontal diseases, diminished masticatory function and multiple teeth impaction have been demonstrated. Alteration in speech value and disturbance in airway have been also reported. Temporomandibular joint (TMJ) dysfunction syndrome has been also recorded after long standing dentofacial malformation. Impairment of psychological and social well being is found in these patients probably due to negative effect on esthetical appearance and self confidence of the individual, Peterson et al., (1997).

Dentofacial malformation can be categorized into two major categories, dental and skeletal malformations. In dental malformation, the discrepancy is limited to dentition of one or both jaws. Orthodontic treatment provides a successful strategy for correction of dental malformation, while in skeletal malformation, the discrepancy occurs in the relationship between upper, lower jaws and the base of the skull. Also, dentofacial malformation includes discrepancies in size as in congenital microsomia and in shape as unilateral mandibular hypoplasia, Mitchell (1996).

Mandibular retrognathia may be congenital or acquired condition. Congenital abnormalities that may exhibit severe mandibular retrognathia include craniofacial anomalies such as hemi facial microsomia, Pierre-Robin syndrome, Treacher-Collin's syndrome, Niger's syndrome and number of others. Acquired abnormalities include post-traumatic and iatrogenic post-surgical scar formation that may induce growth disturbance. Mandibular growth may be adversely affected by condylar fractures that occur at an early age with formation of ankylosis at TMJ and/or deficient mandibular growth, Fonseca et al., (2009).

A great part of orthognathic surgery deals with the correction of discrepancies in mandible and maxilla. Correction of such malformations can be accomplished through osteotomy for adjustment of jaw orientation either in an antro-posterior and / or a vertical direction. The development of mandibular osteotomies for correction of dentofacial deformities had been established as early as 1846, Peterson et al., (1997); Fonseca et al., (2009).

Peterson et al., (1997) reported that since that time, many techniques of mandibular osteotomy had been described. Sagittal split osteotomy (SSO) of the vertical ramus, which was first introduced by Trauner, and Obwegessor in 1951, has become the predominant orthognathic procedure of the mandible to achieve unilateral or bilateral antro-posterior movement. The technique was accomplished via an intraoral approach as described by many authors Peterson et al., (1997); Fonseca et al., (2009).

A wide variety of complications have been reported following SSO of the mandible. These complications may occur during immediate or later postoperatively. Complications that can be happened during surgery as unfavorable fractures, nerve injury or bleeding problems. While complications that could happen immediate postoperatively as infection, parathesia, post operative bleeding or bone nonunion. Later complications occur as skeletal relapse, growth disturbance, Mitchell (1996); Peterson et al., (1997).

Among these complications is the TMJ dysfunction syndrome, which is one of the most common complications. The joint dysfunction may be developed very early postoperatively in the form of limited jaw opening, crepitace and pain, or may develop later as an internal derangement and joint arthritis Peterson et al.,(1997); Fonseca et al.,(2009).

The role of fixation techniques used in SSO on the TMJ is controversy issue. For condylar position changes evaluation, Freihofer et al.,(1975); Kundert and Hadjianghelou et al.,(1980) found that condylar position changes occur greater with rigid than wire fixation. While, many studies reported that no significant mal-positioning of the condyle after SSO surgery, Spitze et al.,(1984); Hackney et al.,(1989); Stroster and Pungrazio(1994).

TMJ dysfunction (TMD), after SSO, also revealed a controversy results with using rigid or nonrigid fixation. Akiyuki et al.,(1997) reported no increase of joint symptoms or an increase in the number of patients with joint dysfunction postoperatively. While other studies suggested that rigid fixation produce greater condylar position changes with subsequent greater incidence of TMD, Athangsiou and Mavreas(1991); Stroster and Pungrazio(1994). While wire fixation provides relatively free movement of the proximal segment by which the condyle lied in the glenoid fossa in a comfortable position. In contrast, Hwang et al.,(2000) reported that condylar resorption occur more in patients with non-rigid fixation and intermaxillary fixation than in patients with rigid fixation. They reviewed this to two reasons, the first reason is the use of intermaxillary fixation for 4 to 6 weeks that could deprive the condyle from its essential nutritive components and necessary functions that make the articulating cartilage becomes thinner and disorganized and the second reason is the condylar torque that happens mostly with wire fixation.

In the same current, many experimental studies had performed for histological evaluation of the joint after SSO. Ueki et al.,(1999) found that sudden skeletal changes induced arthritic tissue reaction in the condyle (demonstrated as clusters of chondrocytes accompanied by hypertrophy of the cartilage). They attributed these changes in the joint to destructive forces produced by sudden skeletal changes. They noticed that the destruction was transformed thereafter into a process of remodeling. The hypertrophic enlargement in the condyle was ended to a stable condition by time dependent tissue adaptation.

Recently, Kundert and Hadjianghelou et al., (1980) have pointed that the pioneer work of Ilizarov in 1962 has resulted in distraction osteogenesis (DO) becoming standard practice in orthopedic than later in maxillofacial surgery. It has been produced promising results in correction of dentofacial malformation. Early reports being mainly concerned with syndrome patients and cases of asymmetry. Distraction osteogenesis offers several advantages to the clinician who is managing cranio-facial anomalies.

DO has major advantages were that it provides the opportunity for lengthening dentofacial structure to a degree not typically possible with traditional techniques. In addition, distraction eliminates donor site morbidity in cases in which bone grafting is used in combination with traditional advancement techniques. Also, distraction provides a method of lengthening of bone while at the same time distracting the surrounding soft tissue matrix. Consequently, distraction gained popularity as a treatment modality and has opened new therapeutic opportunities for the treatment of patient with numerous congenital and acquired skeletal anomalies, Kundert and Hadjianghelou et al.,(1980). Mandibular distraction may be performed either by extra-oral devices which have been used in severe mandibular hypoplastic cases but the percutaneous pins usually led to visible facial scar. Smaller intra-oral devices have been introduced to overcome this problem. In contrast to some multidirectional extra-oral devices, intra-oral distraction can usually only be used for mono-directional lengthening, Stroster and Pungrazio(1994).

Katoda et al.,(2009) demonstrated the effect of unilateral horizontal lengthening on the mandibular body on the TMJ using 3-dimentional finite element analysis.They reported that stress distribution in the joint was greater on the operated side than the non-operated side. In accordance, De Zee et al.,(2007) reported a large difference in the TMJ on the distraction model between left and right compared with the symmetric model for the same loading. They stated that mandibular DO will lead to a change in muscle co-ordination and load transfer to the joint.

Also, Kofod et al.,(2005) studied unilateral vertical mandibular ramus distraction with finite element model based on CT and MRI scans of the patients with unilateral mandibular hypoplasia. In the surgical side, the condyle, disk, and fossa were submitted to increasing loads with increasing elongation compared with contra-lateral TMJ. Loading on the non-surgical side shifted posterior and slightly laterally because of the condyle was the center of rotation. The loading of the TMJ region was low during active distraction phase, although local areas were subjected to elevated peak stresses.

Kitai et al.,(2004) evaluated, twenty TMJ in 10 patients by MRI scanner, the condyle-fossa and disk condyle relationship, disk configuration at closed mouth position and the reduction of the disk at open mouth position. They found 5 of the 10 patients, revealed fairly normal disk- condyle relationship, one patient showed anterior displacement of the disk and four patients had no disk. In two patients, the disk appeared biconcave, in 3 patients, the disk appeared biplanar and in one patient, it was hemi-convex. At the open mouth position, the condyle and disk moved in harmony in five patients with normal disk-condyle relationship. But, the disk was reduced in size with anterior displacement in the rest of patients.

Braun et al.,(2002) reported from clinical study, lateral displacement of the condyle after mandibular symphyseal distraction and the degree of this displacement was in direct relationship to the amount of mandibular lengthening.

Also, Harper et al.,(1997) studied the condylar changes in response to mandibular widening by osteo-distraction. Mandibular midline osteotomies were made in nine Macaca Mulatta monkeys and tooth-borne distraction devices were bonded to the mandibular dentition. Distraction was continued until a 3–5 mm widening was achieved. The appliances were stabilized for a period of 4 weeks. Although three of the seven animals showed no unusual morphology, four others exhibited morphologic differences within the fibrous layer, cartilage layer or bone/cartilage interface. Histological changes were seen to occur in the fibrous layer, cartilaginous layer and cartilage/bone interface. The severity of these changes was correlated with the likely rotational forces directed at the condyle on the postero-lateral and antero-medial surfaces.

2.Materials and Methods:

2.1.Materials:

2.1.1.sample of the study:

The present study was consist of 21 adult male goats (genus Capra – Arabian ibex).The animals were divided into 3groups;two surgical groups, group A (Distraction group), and group B (Orthognathic group) include 9 animals in each, and the third group, group C (control group) contains 3 animals. The animals were weighted in the day of surgery.

2.1.2.Drugs:

- Animals in the surgical groups were prepared for surgery by injection of non-steroidal anti-inflammatory analgesic agent (Felden 1 ml) to decrease the swelling and pain postoperative(: Piroxicam. Pfizer. Cairo Egypt), and a prophylactic antibiotic (Flumox 1 gm, Amoxicillin trihydrate and Flucloxacillin, Eipico Cairo Egypt) 6 hours before operations to guard against infection.
- The surgery was performed under general anesthesia using injection of Thiopentone (Thiopental Sodium. T3A Cairo Egypt) in a dose of 50 mg/kg body weight.
- The hair in the right sub-mandibular region was shaved and the skin was disinfected by Betadine solution(Povidone iodine. Mundipharm, Cairo Egypt).
- The proposed area of surgical intervention was injected with two carpules of Mepevacaine (Mepevacaine,Alexandria Co. Alexandria –Egypt) containing 1/20000 of Levonordefrin to decrease the dose of general anesthesia and hemostasis.
- Amoxil (Amoxicillin, Pfizer, Cairo, Egypt)used for irrigatation of the wound was by sterile saline containing Amoxil

2.2. Methods:

2.2.1. Operation Design:

In both surgical groups A, B: a horizontal skin incision of 5 cm was performed from the angle of the mandible directing interiorly along the inferior border (Fig 1). Another horizontal incision was performed through the muscles layers to expose the buccal side of the body and ramus of the mandible by blunt dissection.

Fig.1: A horizontal skin incision of 5-cm. (in groups A, B)

2.2.1.1.In group (A):

An especial design distraction device was fabricated using a 10 mm stainless steel expansion screw (Dentaurm; Germany: order no.600-301-30) moulded to stainless steel wings to stabilize the expansion screw to the body of the mandible. A tapered fissure bur under copious irrigation by sterile saline attached to micromotor was used to perform a vertical corticotomy at the level posterior to the last molar tooth.

The corticotomy was performed through buccal cortex and down to reaching the lingual cortical bone (Fig.2).

Fig.2: A vertical corticotomy at the level posterior to the last molar tooth was performed using fissure bur in group A

The distraction device was fixed at the centre of corticotomy site using 4 self-tapping screws of 11 mm long (Fig 3, 4).

The wound was irrigated by sterile saline containing Amoxil 1 gm and closed in layers by Vicryl suture 3/0. After 7 days postoperative, the distraction device was exposed under local anaesthesia by a direct incision over the expansion screw, the distraction was preceded at a rate of 1 mm/day for a total distance of 10 mm distraction of bone.

2.2.1.2.in group (B)

Group B in which orthognathic surgery was performed, the osteotomy was performed at the right

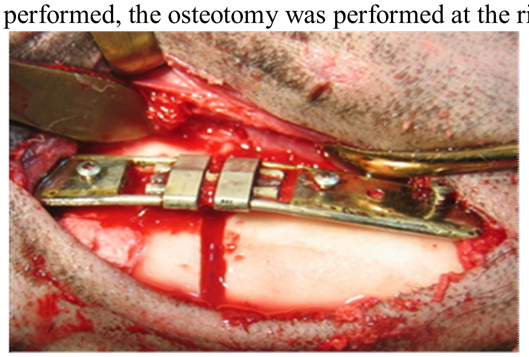

Fig 3: Fixation of distraction device (Group A).

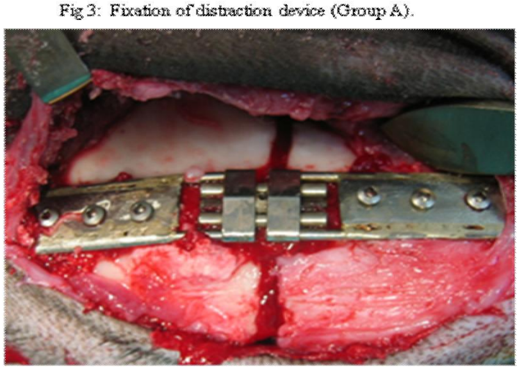

Fig 4: The Activation of distraction device. (Group A)

Side of the mandible by making a vertical cut posterior to molars region along the buccal cortex down to cancellous bone layer and parallel to the posterior border of the ramus using a surgical fissure bur mounted in a straight hand piece under copious irrigation with sterile saline solution. Another horizontal cut was performed along the inferior border and extended from the precursor cut and directed posteriorly to the posterior border of the mandible. A wide –splitting osteotome was used to obtain a split between the two cortexes by gentle tapping along the inferior border of the mandible (Fig 5).

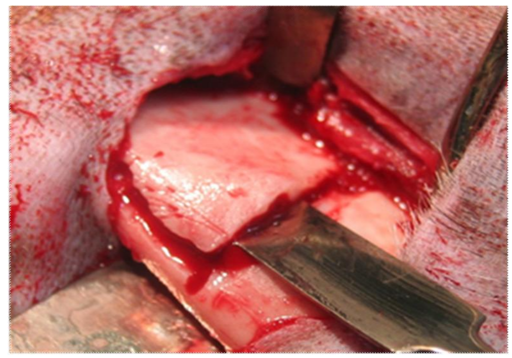

Fig 5: Splitting of the mandible using spatula chisel in group B.

After complete separation, the distal segment was pulled anteriorly to increase the distance between both bony segments by 10 mm. A bone holder was used to stabilize the two segments in the proposed position. The two segments were fixed by 3 stainless steel 2 mm diameter positional screws of 12mm long (Martin; Germany) to secure a bicortical fixation, two superior to inferior alveolar canal and one inferior to the canal , then the wound was irrigated by sterile saline containing Amoxil and closed in layers (Fig 6).

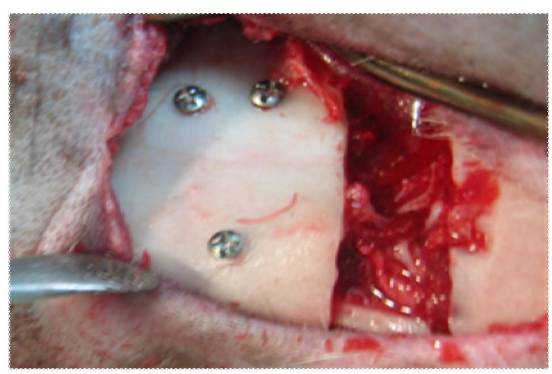

Fig6: Fixation of the two bony segments by positional screws

2.2.2. Postoperative:

Each animal either in-group A or B was injected Felden 1 ml and Flumox 1 gm and continued for 3days as 1 dose/day after operations. The animals were feeded soft diet for 2 weeks postoperatively, later they were returned to usual food.

In-group A, 3 animals were sacrificed at 2, 12 and 24 weeks from the date of achievement of the total planned distraction distance. While in-group B, 3 animals were directly sacrificed at 2, 12 and 24 weeks postoperatively. In-group C, the animals were sacrificed in one interval

2.2.3. Histological evaluation

The head of each animal was fixed in 10% formalin solution for 3 days. The TMJs, ipsilateral and contralateral to surgical side, were removed in blocks. Stripping away the soft tissue was performed to denude the TMJ block. The TMJ tissue block was demineralized in Ethylene Diamine Tetra Acetic acid (EDTA) for 4 weeks. The demineralized specimens were embedded in paraffin wax and sectioned sagittally at 6 microns thickness by microtome , the histological features of TMJ were assessed by light microscope using sections stained with Heamatoxylin Eosin (H&E). The thickness of the fibrocartilagenous layer was measured using analysis software image J 1.29 (NIH, USA) and means of these measurements were assessed for statistical analysis using independent sample t- test.

3.Results

Animals of all groups survived the operation with no postoperative mortality. In all surgical animals, there was shift in the midline.

3.1.Histopathological results:-

3.1.1. Control group:

Sagittal plane sections of the goats' TMJ showed the articular surfaces of the temporal bone convex (articular eminence) anteriorly and concave (glenoid fossa) posteriorly formed of cancellous bone. The fibrous tissue layer covering the articulating surface of the temporal bone was thin in the glenoid fossa. The mandibular condyle was convex and its articular surface is composed of fibrocartilagenous tissue. The articular surface is rounded with a uniform trabecular pattern of bone. The articular disk was a fibrous structure composed of dense connective tissue which was devoid of blood vessels and nerves, and was adapted to resist considerable pressure. The articular disk was thin in the centre and thickened posteriorly and anteriorly. The disk contained few chondroid cells (chondrocyte-like cells).The disk, the condyle and the articular surface of temporal bone were covered by the synovium. The synovial lining was made from 2 to 3 cell layers of synoviocytes (cells forming synovial fluid). The marrow spaces in the temporal bone and condyle contained red and fatty marrow (Fig 7).

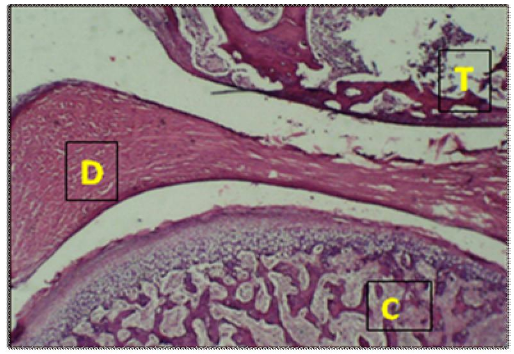

Fig 7: A photomicrograph of the control group showing the normal anatomy of TMJ. D= disk, C= condyle, T= temporal bone

3.1.2.Mandibular Distraction group (group A):

-At 2- weeks' interval:

<u>Right TMJ Sections: (Operated side)</u>

The temporal bone showed increase in the fibrocartilagenous layer with variation in its thickness, there were multinucleated giant cells denoting resorption, the marrow was cellular and fatty. The disk showed increase in the thickness, no sign of perforation was detected. Chondrocyte-like cells could be detected. The condyle showed increase in the thickness of fibrocartilagenous layer compared to control group. No sign of bone denudation or erosion has been detected (Fig 8).

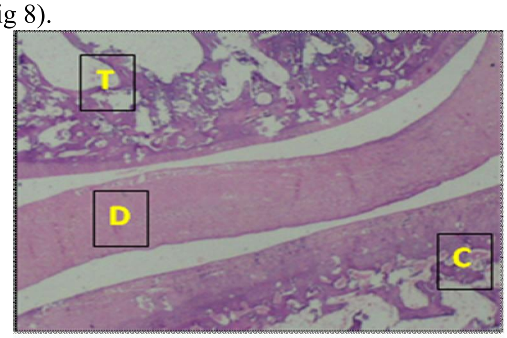

Fig 8: A photomicrograph of right operated side of TMJ of the group (A) 2 weeks postoperatively

<u>Left TMJ Sections: (</u>None-operated side)

The temporal bone showed that the fibrocartilagenous cap had interruption and discontinuation of this layer. Thinning in the fibrocartilagenous layer was also noticed. Multinucleated giant cells were also detected. The marrow spaces were wide and they contents were cellular and fatty. The disk increased in thickness and contained many chondrocyte like cells. No evidence of disk perforation could be detected. The condyle showed that the fibrocartilagenous layer was decreased in thickness, no evidence of bone erosion or denudation (Fig 9).

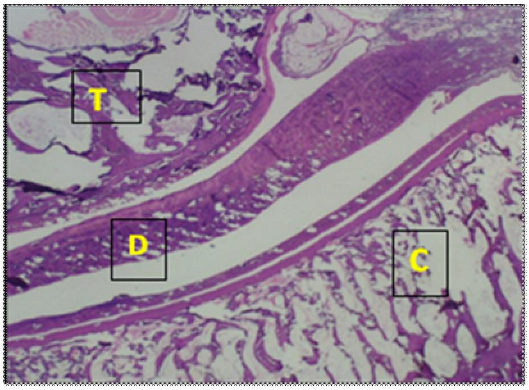

Fig 9: A photomicrograph of left nonoperated side of TMJ of the group (A) 2 weeks postoperatively

-At 12-weeks Interval:

Right TMJ Sections: (Operated side)

Temporal bone showed decrease in the thickness of fibrocartilagenous layer, marrow was cellular and fatty. The disk showed decrease in thickness in uniform pattern with no sign of disk perforation with Chondrocyte- like cells were also observed inside it. The condyle showed thinning of the fibrocartilagenous layer but still covered the underlying bone; multinucleated giant cells were also noted denoting resorption. No sign of bone erosion has been detect (Fig 10).

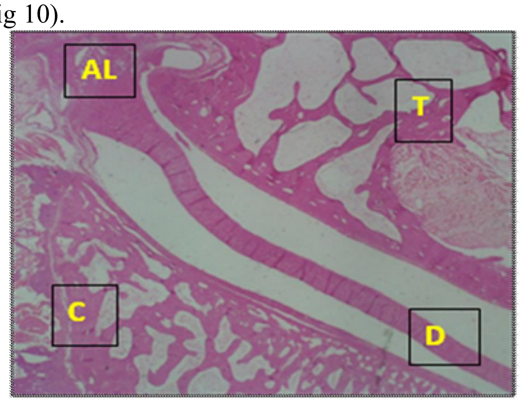

Fig 10: A photomicrograph of right operated side TMJ of the group (A) 12 weeks postoperatively

Left TMJ Sections: (Non-operated side)

Temporal bone showed decrease in the thickness of fibrocartilagenous layer covering the glenoid fossa with variation in the thickness; the bone marrow was mainly cellular. The disk has decreased in its thickness without any sign of perforation, and contained chondrocyte like cells. The condyle showed decrease in the thickness of fibrocartilagenous layer with variable thickness. No sign of bone exposure has been detected (Fig 11).

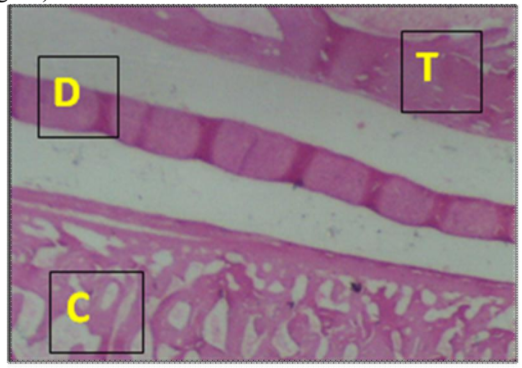

Fig11: A photomicrograph of left nonoperated side of TMJ of the group (A) 12 weeks postoperatively

-At 24-weeks Interval:

Right TMJ Sections: (Operated side)

The temporal bone showed interruption and discontinuation of the fibrocartilagenous layer. There were many multinucleated giant cells denoting resorption. The marrow spaces were wide and cellular. The disk was increased in thickness with presence of chondrocyte like cells with no evidence of perforation could be detected. The condyle showed again increase in thickness but in uniform pattern, with no evidence of bone erosion or denudation could be detected (Fig 12).

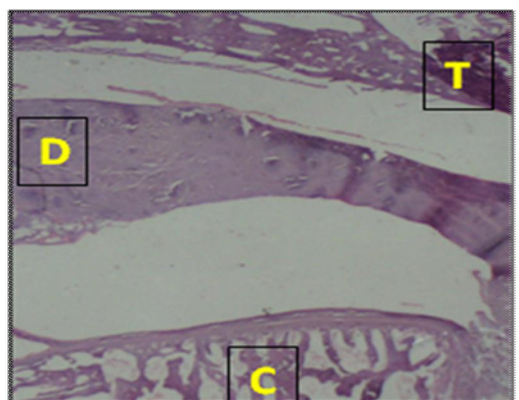

Fig 12: A photomicrograph of right operated TMJ of the group (A) 24 weeks postoperatively

Left TMJ Sections: (Non-operated side)

Temporal bone showed increase in the thickness of the fibrocartilagenous layer in uniform pattern. The marrow spaces were cellular and fatty. The disk showed increase in the thickness with presence of chondrocyte like cells with no evidence of disk perforation could be detected. The condyle showed variable thickness of fibrocartilagenous layer with decrease in its thickness in certain areas compared to control group. No evidence of bone erosion could be detected (Fig 13).

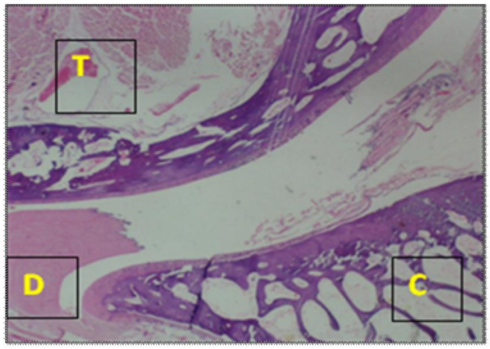

Fig 13: A photomicrograph of left nonoperated side of TMJ of the group (A) 24 weeks postoperatively

3.1.3. Mandibular advancement group:
***At 2-weeks Interval*:**
Right TMJ sections: (Operated side)

There was thinning in the fibrocartilagenous layer covering the fossa. The marrow spaces were wide and cellular and fatty; areas of small resorption were seen. The disk was increased in thickness and became more fibrosis. The synovial lining of the disk were interrupted. No evidence of disk perforation. Chondrocyte like cells were also seen. The condyle showed increase in the thickness of fibrocartilagenous layer uniformly. No sign of bone erosion or exposure has been detected (Fig 14).

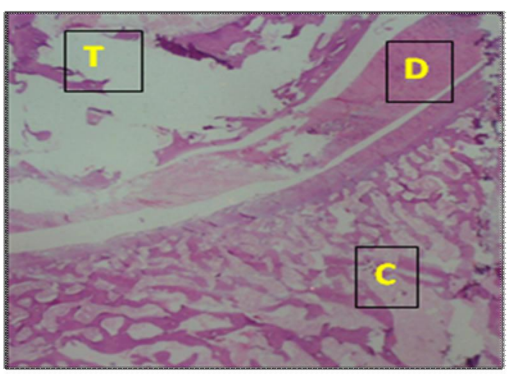

Fig 14: A photomicrograph of right operated side of TMJ of the group (B) 2 weeks postoperatively

Left TMJ sections: (Non-operated side)

Temporal bone showed that the fibrocartilagenous cap had interruption, thinning and discontinuation. The marrow spaces were wide and they contents were cellular and fatty. Many multinucleated giant cells were observed. The disk showed increase in the thickness with presence of chondrocyte-like cells. There was interruption in the synovial lining. No evidence of disk perforation could be detected. The condyle showed increasing in the fibrocartilagenous layer with variation in their thickness. No evidence of bone erosion or denudation could be detected (Fig 15).

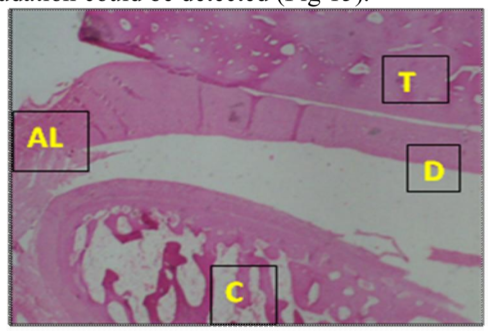

Fig 15: A photomicrograph of left nonoperated side of TMJ of the group (B) 2 weeks postoperatively.

***-At 12- weeks Interval*:**
Right TMJ Sections: (Operated side)

Temporal bone showed decrease in the thickness of the fibrocartilagenous layer, the marrow spaces were within control size, the marrow was cellular and fatty with multinucleated giant cells were detected denoting resorption. The disk was within control thickness and uniform shape in certain areas and atrophic in other areas. No sign of disk perforation was detected. The condyle showed decrease in the thickness of fibrocartilagenous layer, there were variation in the thickness of the fibrocartilagenous covering, there were multinucleated giant cells. No sign of bone erosion has been detected (Fig 16).

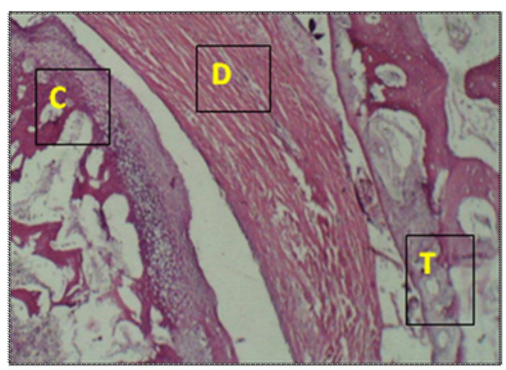

Fig 16: A photomicrograph of right operated side of TMJ of the group (B) 12 weeks postoperatively.

Left TMJ Sections: (Non-operated side)

Temporal bone showed decrease in the thickness of fibrocartilagenous coverage with variation in its thickness. The marrow spaces were cellular and fatty.

The disk was atrophic and fibrosis with no evidence of disk perforation. The condyle showed variation in the thickness of the fibrocartilagenous coverage with thinning of its layer. Absence of the fibrocartilagenous layer was observed in certain areas exposing the underlying bone. Multinucleated giant cells were also observed (Fig 17).

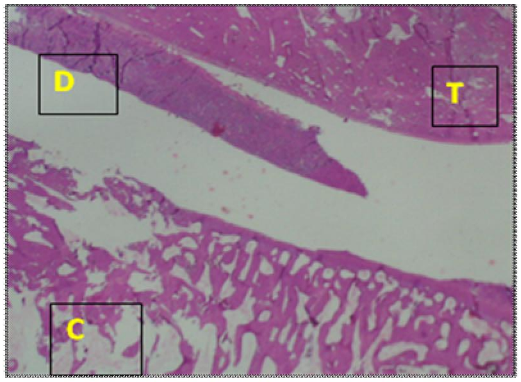

Fig 17: A photomicrograph of left nonoperated side of TMJ of the group (B) 12 weeks postoperatively

- *At 24-weeks Interval:*

<u>Right TMJ Sections: (</u>Operated side<u>)</u>

The temporal bone showed interruption and discontinuation of the fibrocartilagenous layer and there were many multinucleated giant cells denoting resorption. The marrow spaces were wide and cellular. The disk showed again hyperplasia and fibrosis with presence of chondrocytes-like cells with no evidence of disk perforation could be detected. The condyle showed variable thickness of fibrocartilage layer. No evidence of bone erosion or denudations could be detected (Fig 18).

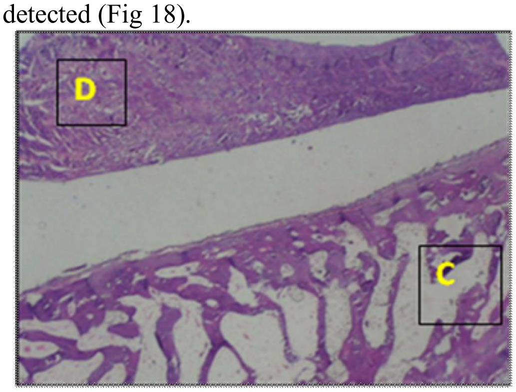

Fig 18: A photomicrograph of right operated side of TMJ of the group (B) 24 weeks postoperatively

<u>Left TMJ Sections:</u> (Non-operated side)

Temporal bone showed increase in the thickness of fibro-cartilaginous layer with variation in this thickness, the bone marrow was cellular and fatty. No sign of bone erosion or exposure could be detected in the sections. The disk showed hyperplasia with presence of chondrocyte like cells with no evidence of disk perforation could be observed. The condyle gained some increase in the thickness of fibro cartilaginous layer with presence of scant areas of bone resorption. No evidence in bone erosion has been detected (Fig 19).

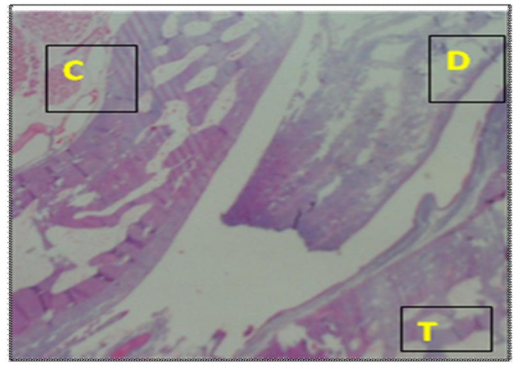

Fig 19: A photomicrograph of left nonoperated side of TMJ of the group (B) 24 weeks postoperatively

4.Discussion

In fact, both mandibular advancement and mandibular distraction will cause change in architecture of the musculatures around the mandible. Mandibular advancement will directly cause sudden changes in the musculature, while mandibular distraction will cause gradual effect. These changes in muscles architectures will lead to disturbance in mechano-dynamic balance around the mandible during rest and function. As mandible and TMJ are considered a single unit; the imbalance in mechanical loads will transfer to the joint. If the intrinsic adaptive capacity of the joint fails to counteract these loads, joint arthritis will be precipitated, Peterson et al.,(1997).

In this study unilateral mandibular advancement or distraction caused a shift of the midline toward the opposite side which caused two effects: the first was rotational and posterolateral displacement of the contralateral condyle in relation to other components inside the joint .The second was displacement of both masseter and medial pterygoid muscles in the contralateral side. These effects happened immediately after mandibular advancement and gradually after mandibular lengthening. The two effects caused changes in fossa – disk – condyle relationship and disturbance in load equilibrium inside the joint. Changes in condylar position, either at rest or during mouth opening created a pressure (compression) area and a tension area inside the joint. These changes stimulate the adaptive remodelling capacity inside the joint which take two forms either progressive or regressive remodelling.

The resorption of the articular surfaces of TMJ are mostly attributed to two main reasons, the first is extracapsular loading that is directly able to initiate a regressive remodeling of the articulating surfaces. The second is either due to severe disk displacement or disk perforation that leads to direct articulation of the condyle to the temporal bone with subsequently wearing of the articular cartilages for both condyle and temporal bone and exposure of subchondral bone. If bone resorption occurred only in one articular surface, the only explanatory factor for this resorption is the mechanical loading exerted upon this surface.

The histological analysis of this study showed subjecting of the temporal bone to mechanical loading of a higher magnitude that was sufficient to initiate arthritic changes in the articular surface of temporal bone. These arthritic changes were regressive in nature, both in distraction and advancement groups. Histologically, the articular surfaces showed areas of resorption with presence of multinucleated giant cells and thinning of the fibrocartilage layer with interruption of synovial lining. In some sections, the fibrocartilagenous tissues were seen, denoting the adaptive capacity of the articular surface in which the resorptive areas were initially filled by undifferentiated mesenchyme that changed into a fibrocartilage tissue. At the end of the study, the thickness of the fibro-cartilage covering the temporal bone regained almost a control size.

The articular disk of the TMJ in groups (A and B) showed initial increase in thickness and numbers of chondrocytes like cells 2 weeks postoperatively. The changes were greater in advancement group compared to distraction group and these changes were greater in non-operated rather than operated sides. While at 12 weeks postoperatively, the thickness reduced and the disk showed atrophy. The decreases in thicknesses were greater in advancement group especially non-operated side. Later, the disk again acquired some increase in thickness with increased numbers of chondrocytes like cells both in group (A and B)

The results of this study coincided with that demonstrated by Ueki et al.,(1999) who found that sudden skeletal changes induced arthritic tissue reaction in the condyle. They attributed these changes in the joint to destructive forces produced by sudden skeletal changes.

Monje et al.,(1993) found antro-inferior displacement of the temporal and mandibular component of the joint, flattening of the mandibular condyle, and lateral thickening of the articular disk. They observed that changes in the joint components were more marked and transient in nature in growing rats than in adult animal in which the joints were less affected but permanent in nature.

Also,Katoda et al.,(2009) demonstrated the effect of unilateral horizontal lengthening of the mandibular body on the TMJ; they reported that stress distribution in the joint was greater on the operated side than the non-operated side.

Karaharju-Suvanto and Peltonen (2006) studied condylar changes in 17 growing sheep. They found gradual lengthening of the mandible affected both operated and contralateral condyles. An enhancement of the endochondral ossification was noticed with marked osteoblastic activity between the cartilaginous layer and the bone formed. The cartilage was thinner and the bone structure more dense than in non-operated controls, and woven bone predominated.

In the opposite side; Per Lanneret et al .,(1991)found that bone marrow of mandibular condyle was normal in all patients with no sign of avascular necrosis of the condyle after sagittal split osteotomy. They concluded that narrowing of marrow spaces and thickening of cortical bone of proximal segment most likely represent remodeling process associated with normal healing process.

Bell et al,,(1990); Bell and Yamaguachi et al .,(1991) recorded immediate resolution of symptoms in the joint dysfunction patients treated by ramus osteotomy and reviewed these result to improvement of fossa-disk-condyle relationship and unloading of the retrodiskal tissues.

Also, Gunbay et al.,(2009) found the patients received trans-mandibular distraction that there were no permanent TMJ dysfunctions.

Kewitt and Van Sickles (1999) found that of 47% of the patients with TMJ symptoms pre-operatively, no patients had symptoms worsening or developed new symptoms postoperatively. Five patients, TMJ symptoms improved and three patients experienced complete resolution of joint dysfunction.

Controversy results found in the literature for TMJ after both mandibular advancement or lengthening, can be attributed in my opinion to many factors:

(1) Amount of load excreted over the joint, as undue forces over the joint not only coming from the technique itself but also it may be due to other factors as malpositioning of condylar segment, rate of mandibular movement and degree of these movement.

(2) Age of the patient as intrinsic remodelling capacity is higher in young patients.

(3) Method of evaluation of the joint postoperatively as most of studies either used radiographic evaluation to measure changes in condylar position (change in condylar position is not an evidence for development of joint dysfunction), questionnaire tests about signs and symptoms of joint which is doubtful, or histological evaluation of the joint in an experimental animal.

(4) Post-operative evaluation time as initial arthritic changes of the joints may occur postoperatively but later they may end to a stable condition.

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