

# Distraction Osteogenesis for Mandibular Ramus lengthening in Temporomandibular Joint Ankylosis Patients simultaneously with Interposition Gap Arthroplasty

SHAHZAD IQBAL MALIK<sup>1</sup>, SAADIA FIRDOUS<sup>2</sup>, TOOBA SAEED<sup>3</sup>, SABA HANIF<sup>4</sup>, HAFIZ NASIR MAHMOOD<sup>5</sup>, KASHIF KHATAK<sup>6</sup>, SADIA ZAFAR<sup>7</sup>, SANA CHAUDHRY<sup>8</sup>

<sup>1</sup>Assistant Professor de'Montmorency College of Dentistry Lahore

<sup>2</sup>Assistant Professor OMFS Avicenna Dental College Lahore

<sup>3</sup>Assistant Professor OMFS University of Lahore

<sup>4</sup>Demonstrator OMFS KEMU

<sup>5</sup>Assistant Professor CMH Lahore

<sup>6</sup>Demonstrator de'Montmorency College of Dentistry Lahore

<sup>7</sup>Professor Physiology Avicenna Medical College Lahore

<sup>8</sup>Associate Professor Avicenna Dental College Lahore

Corresponding author: Shahzad Iqbal Malik, Email: [shahzadbabbar@yahoo.com](mailto:shahzadbabbar@yahoo.com), Cell: 03214309188

## ABSTRACT

Temporomandibular joint ankylosis is the most common cause of facial deformity.<sup>1-4</sup>The main etiology of TMJ ankylosis include trauma and infection<sup>3,5</sup>.TraditionallyTemporomandibular joint Ankylosis patients had been managed with different treatment options including Gap arthroplasty<sup>6</sup>,Interpositiongap arthroplasty ,distraction osteogenesis and total joint replacement.To prevent reankylosis interposition of fascia or muscle had been documented and if reconstruction of the joint was needed Alloplastic(sialistic)or Autogenous graft ( Costochondral bone graft) had been used.<sup>6, 7,8,9</sup> Costochondral graft is preferred for reconstruction because morphological it is similar to the condyle of mandibleandhas agrowth capacity.<sup>9</sup>But thisgraft is unpredictable in nature and different results are reported and documented including facial asymmetry, over growth, graft resorption, graft failure and even reankylosis.<sup>9</sup>

Distraction osteogenesis is a recent treatment method for the correction of hypo plastic mandible in Temporomandibular joint ankylosis patients. By using distraction osteogenesislarge skeletal movements are possible with little or no relapse commonly seen in other orthognathic corrections.

In this study of 30 patients all patients were treated with TMJ Interposition gap arthroplasty (interposition of temporalis fascia) followed by the application of distractors at ramus of mandible. Mean age was14.96±4.17 years. Patient's minimum and maximum age was 8 and 24 years respectively. Gender distribution shows that 15(50%) of the patients were male and 15(50%) were females. Male to female ratio was 1:1.Mean ramus length before distraction was 38.70±7.28 mm with 28-52 mm range. Mean ramus length after distraction osteogenesis was 49.00±8.01 mm. Mean increase in vertical ramus length was 10.26±2.86 mm. Minimum increase was 5mm and maximum increase in vertical ramus length was 15 mm respectively. In this study we were able to achieve increase in ramus length in all patient and only patient require reoperation due to failure of distractor appliance which was replaced successfully.

## INTRODUCTION

The concept of skeletal molding is not new and has been practiced by various cultures for thousands years. First skeletal molding was documented on Neanderthal skulls (45,000 BC)<sup>1</sup>. Greek shape the head of their infant's with mold after birth while French, consider conical head shape as a sign of aristocracy.

Distraction osteogenesis is now a very popular<sup>1</sup> and reliable method <sup>2</sup>for the correction of facial deformities. In 1905 Distraction osteogenesis was first described by Codvillabut the idea of distraction was popularized in 1988 by Ilizarov. First successful craniofacial distraction was done in mandible by McCarthy and his team in 1989.<sup>2,12,16</sup>InDistraction osteogenesisviable bone is formed by the gradual separation of callus in osteotomized bone segments by a device. The device (distractor) also exert force on to the surrounding soft tissuesand results in adaptive changes in it known as tissue histiogenesis.Under the gradual distraction an active histiogenesis take place in soft tissues including skin, blood vessels, nerves, muscles, cartilages, ligaments and periosteum which causes increase in soft tissue along with bone. Due to these adaptive changes larger skeletal movements are possible with minimizing the chancesof relapse commonly seen in orthognathic corrections. Initially this technique was used mainly for the correction of congenital mandibular deformities<sup>13</sup>. With recent advancesin surgical technique<sup>10</sup> as well as technical equipment Distraction osteogenesis is now being used for non-syndromic deformities like for the reconstruction mandibular continuity defect (due to pathology, trauma or gunshot) and for the correction of hypo plastic mandible<sup>12</sup> in Temporomandibular joint ankylosis.

Temporomandibular joint ankylosis is very common in Pakistan due to non-availability of maxillofacial surgery department at primary and secondary health care level. Long standing

Temporomandibular joint ankylosis leads to hypo plastic mandible due to damage of the condyle of mandible.Traditionally temporomandibular joint ankylosis patients are managed surgically for correction of ankylosis as well as mandibular deformity. Surgical options include gap arthroplasty, interposition gap arthroplasty, interposition gap arthroplasty with Costochondral graft<sup>6,7,10</sup> and interposition gap arthroplasty with sialistic

With all the methods mentioned above for the management of Temporomandibular joint ankylosis only a satisfactory mouth opening is achieved and for the correction of mandibular deformities separate treatment method is required.

Distraction osteogenesis is an alternate management option for the correction of hypo plastic mandible in Temporomandibular joint ankylosis patients as bone grafting and second stage surgery for the correction of mandibular deficiency can be prevented.

**Objective:** The aim of the study was to evaluate the use of distraction osteogenesis for mean increase in vertical ramus length simultaneously with interposition gap arthroplasty in TMJ ankylosis patients.

**Operational Definition:**

**Surgical Procedure:** After Interposition gap arthroplasty distracter will be applied after completion of horizontal ramus osteotomy.

**Vertical Bone Lengthening:** It was the distance from condylin (Co) to Gonion (Go) and was measured in mm and it was assessed at

1. **Latency period (phase):** It was the period when early stage of bone healing (callus formation) begin to take place at the osteotomy bony interface. Length was assessed at 7<sup>th</sup> day and it will be taken as T1.

2. **Distraction phase:** In distraction phase bony interfaces have been separated from each other by activating the distracter up to the required length. It was taken as T2.

3. **Mean increase in vertical ramus length** was obtained by taking the difference of T2 and T1 i.e. (T2-T1)

## MATERIALS AND METHODS

**Setting:** Department of Oral and Maxillofacial Surgery KEMU/Mayo Hospital, Lahore.

**Duration:** From July 2018 till Feb 2021.

**Sample Size:** Sample size of 30 patients is calculated with 95% confidence level,  $d=1$  and taking mean  $\pm$  S.D of mean increase in ramus length i.e.  $20.2 \pm 2.1$

**Sample Technique:** Non- probability purposive sampling.

### Sample Selection

#### Inclusion criteria:

- 1 Male and female of age ranges between 5-25 years.
- 2 Patient with hypoplastic mandible due to TMJ Ankylosis.

#### Exclusion Criteria:

- 1 Patients who refused to be included in the study.
- 2 Patients who have syndrome associated TMJ ankylosis.
- 3 Patient who have TMJ Ankylosis due to underlying pathology (on x-rays and clinical examination).
- 4 Patient who are medically compromised.
- 5 Patients who have known metal allergies.
- 6 Patient who are uncooperative and who cannot follow instructions and who don't know the importance of procedure.

**Study Design:** Quasi experimental Study.

**Data Collection Procedure:** Thirty patients fulfilling the inclusion criteria were selected from the Outpatient department of Oral & Maxillofacial surgery, Mayo Hospital, Lahore. Study was conducted after approval from the ethical committee of Mayo Hospital, Lahore and obtaining informed consent from the patient.

Demographic detail, history, examination, photograph and radiograph (OPG, PA Cephand Lateral Ceph) of the patient were obtained and assessed to find out mandibular deficiency, required bone lengthening and plan was made for future Interposition Gap Arthroplasty and osteotomy cut for distractor placement. Under General Anesthesia Interposition Gap Arthroplasty, Osteotomy and application of distracter was done extra orally in all patients. Patients were retained in hospital in latency phase and during the latency period PA Ceph was repeated to measure mandibular length and it was labeled as T1. On 7<sup>th</sup> Post op day activation of the appliance was done. Distraction was done at a rate of 0.5mm twice daily till the required lengthening was achieved clinically, PA Ceph was repeated. length was measured and it was labeled as T2.

Device was kept during consolidation phase and where removed after consolidation phase had ended

**Data Analysis:** All collected data was entered and analyzed by using Statistical Package for Social Sciences (SPSS).

Quantitative variables like mean increase in bone length and age were documented as mean and standard deviation and Data was stratified for age (<8,>8). Qualitative data like gender was presented in the form of frequency and percentages; mean increase in vertical length was obtained by taking difference of T2-T1 i.e.(T2-T1)

## RESULTS

Total 30 patients were included in this study that full filled the inclusion and exclusion criteria. Mean age of all 30 patients was  $14.96 \pm 4.17$  years. Patient's minimum and maximum age was 8 and 24 years respectively while mean age of male and female patients was  $15.26 \pm 4.71$  and  $14.66 \pm 3.69$  years respectively. Male patient's age was a bit higher than that of female patients. (Table-1) Gender distribution shows that 15(50%) of the patients were male and 15(50%) were females. Male to female ratio was 1:1(Figure-1)

Mean ramus length before distraction of all 30 patients was  $38.70 \pm 7.28$  mm. Range of ramus length was 28-52 mm. Patients

age was stratified in two groups i.e. <8 and >8 years. In patients who were <8 years their mean ramus length before distraction was  $32.00 \pm 2.00$  and patients who were >8 year their mean ramus length without distraction was  $39.44 \pm 7.28$  mm. (Table-2)

Mean ramus length with distraction osteogenesis all patients was  $49.00 \pm 8.01$  mm. Patients were stratified on the basis of their age in two groups i.e. <8 and >8 years. Patients whose age was <8 years their mean ramus length with distraction osteogenesis was  $38.33 \pm 0.57$  and patients whose age was >8 year their mean ramus length with distraction osteogenesis was  $50.18 \pm 7.55$  mm respectively. (Table-3)

Increase in Vertical ramus length was calculated by subtraction of ramus length with distraction osteogenesis by ramus length before distraction osteogenesis. Mean increase in vertical ramus length was  $10.26 \pm 2.86$  mm. Minimum increase was 5mm and maximum increase in vertical ramus length was 15 mm respectively. (Table-4)

Mean increase in vertical ramus length was  $6.33 \pm 1.52$  mm in patients who were <8 years. Patients who were >8 years of age in them mean increase in vertical ramus length was  $10.70 \pm 2.64$  mm respectively. Patients whose age was >8 years in them increase in vertical ramus length was greater as that of patients who were <8 years of age. (Table-5)

Table-1: Age and Gender Relation Statics

	Gender		Total
	Male	Female	
N	15	15	30
Mean	15.26	14.66	14.96
SD	4.71	3.69	4.17
Minimum	8.00	8.00	8
Maximum	24.00	20.00	24

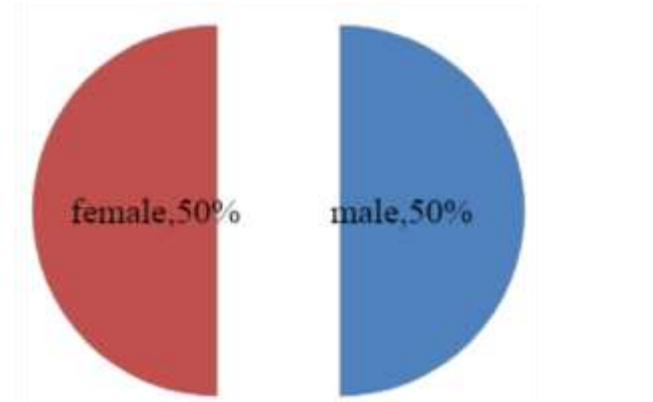


Figure 1: Gender Distribution of Patients

Table-2: Descriptive Statistics For Mandibular Ramus Length Before Distraction Osteogenesis (T1) mm

	Age Group		Total
	<8 Years	> 8 Years	
N	3	27	30
Mean	32.00	39.44	38.70
SD	2.00	7.28	7.28
Minimum	30	28	28.00
Maximum	34	52	52.00

Table-3: Descriptive Statistics For Mandibular Ramus Length With Distraction Osteogenesis (T2) mm

	Age Group		Total
	<8 Years	> 8 Years	
N	3	27	30
Mean	38.33	50.18	49.00
SD	0.57	7.55	8.01
Minimum	38.00	39.00	38.00
Maximum	39.00	65.00	65.00

Table-4: Descriptive Statistics For Mean Increase In Vertical Ramus Length mm (T2-T1)

	T1	T2	Increase in Vertical Ramus Length (T2-T1)
Mean	38.70	49.00	10.26
SD	7.28	8.01	2.86
Minimum	28.00	38.00	5.00
Maximum	52.00	65.00	15.00

Table 5: Descriptive Statistics For Mean Increase In Vertical Ramus Length (T2-T1) Mm In Relation To Age Group

	Age Group		Total
	<8 Years	>8 Years	
N	3	27	30
Mean	6.33	10.70	10.26
SD	1.52	2.64	2.86
Minimum	5	5	5.00
Maximum	8	15	15.00

**DISCUSSION**

Traditionally temporomandibular joint ankylosis patients are managed surgically for correction of ankylosis as well as mandibular deformity. Surgical options include gap arthroplasty, interposition gap arthroplasty, interposition gap arthroplasty with Costochondral graft<sup>6,7,10</sup> and interposition gap arthroplasty along with sialastic.

In gap arthroplasty excision of the ankylotic bone is done in order to create a gap between the ramus and glenoid fossa. The gap of 1-1.5 cm is created to prevent re ankylosis aggressive physiotherapy is required for longer duration. While in Interpositiongap arthroplasty in addition to gap arthroplasty interpositioning is done either with autogenous grafts or withalloplastic material to prevent direct contact between ramus and glenoid fossa.<sup>9</sup>Verneuil A introduced use of temporalis flap to separate ramus of mandible from glenoid fossa after gap arthroplasty in the temporomandibular joint ankylosispatients (interposition gap arthroplasty). Significant pain on function was documented when this flap was used. It was suggested that pain was felt due to rotation or compression of sensory innervationpresent in the flap. Warraich RA<sup>8</sup> in his study used Temoralis fascia flap in inter position gap arthroplasty and he found that use of temporalis fascia reducedpostoperative pain. Fascia is strong enough to prevent reankylosis so prolonged physiotherapy is not required

With all the methods mention above satisfactory mouth opening and re-ankylosis prevention can be achieved but for the management of mandibular hypoplasia a separate treatment option is required in Temporomandibular joint ankylosis Patients. Gillies<sup>9</sup> used Autogenous Costochondral graft for temporomandibular joint reconstruction.Costochondral graft is preferred in children because of its growth potential and is morphologically similar to the condyle of mandible .<sup>9</sup> It provides a growth center in children, while in adults it is used for maintaining of posterior facial height and prevention of jaw deviation<sup>10</sup>. Since Costochondral graft has unpredictable nature and often it may result in facial asymmetry, over growth, graft failure, resorption and even reankylosis. As Costochondral graft is autogenous in nature sodonor site morbity is unavoidable.<sup>9</sup>

Distraction osteogenesis is a relatively newmethod for the correction of mandibular deformities due to the Temporomandibular joint ankylosis <sup>2</sup>.In 1992, McCarthy et al<sup>1,15,16</sup> used Distraction Osteogenesis for the mandibular lengthening on four syndromic patients who have mandibular deficiency <sup>13</sup>. In his study he used extra oral distractors and was able to achieve mandibular lengthening in all four patients. Both studies are similar as far as achievement in lengthening is concern as required lengthening is achieved in both studies. But current study differs from his study as number of patients involved in current study are thirty while his study involved only four patients.

In their study Krishna and Sudhir<sup>18</sup> discussed the role of simultaneous gap arthroplasty and distraction osteogenesis for the

treatment of mandibular hypoplasia in temporomandibular joint ankylosis children. Their study included six children with mean age of 8.5 years. They were able to increase mandibular body length up to 19mm. Their study differs from current study as in their study the lengthening was achieved in body area so they achieved large lengthening upto 19mm while in current study lengthening is achieved in vertical direction in mandibular ramus area so achieved lengthening was not that large and upto 15mm length achieved in patients who are 8< years while who are 8> lengthening was achieved upto 8mm. Moreover, in their study six patients were studied and their ages ranged from 7 to 10 years while in current study thirty patients are studied and their ages range from 8 to 24 years.

In their study Yoon and Kim<sup>17</sup> successfully used gap arthroplasty with intraoral mandibular distraction osteogenesis in two TMJ ankylosis patients with mandibular deformity. Both the patients had undergone failed gap arthroplasty and costochondral graft interposition. Their study reported a positive result with total follow up for two years.Their study differs from current study as in their study both the patients were female while in current study male to female ratio is 1:1. Moreover over their study involved only two patients while current study involved 30 patients

C.Liang and colleague<sup>19</sup>had done their study on adult with long standing Temporomandibular joint ankylosis. They used transport disc distraction osteogenesis arthroplasty (TDOAP) for the management of their patients. Their study included 32 adult patients with age range of 18 to 61 years. They successfully corrected facial deformities in all their patients and were able get mean increase in mandibular length of 15.4mmwhich is higher than current study mean increase in vertical ramus length of 10.26±2.86 mm. They had achieved large lengthening because their study included adult patients (age range of 18 to 61)and for the correction mandibular deformityin these patient'slarge bone lengthening was required while current study was conducted on adult and young patients with age range of 8 to 24 so large lengthening was not required for correction of mandibular deformity. In current study mean increase in vertical ramus length is 6.33±1.52 mm in patients who were <8 years while Patients who were >8 years of age in them mean increase in vertical ramus length was 10.70±2.64 mm.

M.Iwata and M.Okubo, had done a study on bilateral TMJ ankylosis patients. They used distraction osteogenesis after one year of interposition gap arthroplasty procedure. In their study they evaluated this technique on 20 patients ranged in age from 23 to 45. They treated all patients successfully and found that all patients ended with symmetrical chin position. Both studies are similar as ramus lengthening is successfully achieved in both. Their study is different from current study as their study involved 20 patients while current study was done on 30 patients, and in their study they used distraction osteogenesis after one year of interposition gap arthroplasty while in current study interposition gap arthroplasty and distraction osteogenesis are applied simultaneously.<sup>30</sup>Moreover current study is also different in age range from their study as current study involved age range of 8 to 24 years while their study involve age range from 23 to 45.

Aysegul Mine and Rehaiin their study discussed the stability of vertical ramus lengthening with distraction osteogenesis in Temporomandibular joint ankylosis patients. Their study included eight non syndromic Temporomandibular joint ankylosis patients with age range of 17 to 33. These patients were treated with gap arthroplasty followed by distraction osteogenesis. Bone lengthening was achieved up to 18mm. Both studies are comparable and involve non syndromic Temporomandibular joint ankylosis patients, ramus lengthening is also comparable as lengthening is achieved in ramus of the mandible upto 18mm in their study and up to 15mm in current study. Their study differs from current study as their study involve eight adult patients with age range of 17 to 33 while current study involved 30 patients with age range of 8 to 24 <sup>2</sup>.

Interposition gap arthroplasty followed with Distraction osteogenesis isreliableand only method to address both ankylosis

and mandibular deformity in Temporomandibular joint ankylosis patients. In our study we were able to achieve mandibular lengthening in all 30 patients successfully and lengthening was achieved up to 15mm. Out of thirty patients involved in this study only one patient has complication during distraction phase due to device failure. Patient was re operated and distractor was replaced which work perfectly and required lengthening was achieved successfully.

## CONCLUSION

Distraction osteogenesis for mandibular ramus lengthening in temporomandibular joint ankylosis patients simultaneously with interposition gap arthroplasty is a very effective method for management of Temporomandibular Joint ankylosis patients. Currently it is the only method that address both ankylosis and mandibular deformity at the same time. This method is equally effective in the management of pediatric as well as in adult patients with TMJ ankylosis.

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