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ORIGINAL ARTICLE

Arthroplasty Followed by Distraction Osteogenesis Versus Distraction Osteogenesis Followed by Arthroplasty in the Management of TMJ Ankylosis: A Comparative Study

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Abstract

Aim To compare treatment outcome of arthroplasty followed by distraction osteogenesis (AFD) and distraction osteogenesis followed by arthroplasty (DFA) in the management of mandibular deficiencies in temporomandibular joint (TMJ) ankylosis.

Materials and methods A total of 20 patients with TMJ Ankylosis were included in the study. Patients were randomly divided into two groups. Group 1 consisted of patients for whom arthroplasty was done prior to distraction osteogenesis (AFD) for the correction of deficient mandible. Group 2 included patients where distraction osteogenesis was performed prior to arthroplasty (DFA). The treatment outcome was assessed based on maximum interincisal distance, overjet, corpus length, ramus height, upper airway, lower airway, duration of the procedure and the complications for the treatment at the end of 3, 6 and 12 months.

Results After the treatment was ended, the patients of both groups had increase in mouth opening and appearance was improved remarkably. There was general increase in all the parameters in both the groups. But at the end of 12 months, airway and the ramus height were more stable and the control of the proximal segment was superior in DFA group. Open bite was noticed in 2 cases of AFD group which was treated by elastics. There required additional surgery for the removal of distractors in the AFD Group. Establishing the airway during the surgery was easier in AFD group.

Conclusion The study concludes that distraction followed by arthroplasty was a better procedure for the management of TMJ ankylosis owing to its stable results and less number of surgeries.

Keywords TMJ ankylosis · Distraction osteogenesis · Arthroplasty · Retrognathia · Airway

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Introduction

Temporomandibular joint ankylosis is one of the most debilitating joint disorders adversely affecting the quality of life. It hampers both facial aesthetics and functional movement of jaws [1]. Ankylosis of the temporomandibular joint (TMJ) involves the fusion of the mandibular condyle to the base of the skull, which causes distressing conditions including impaired speech, difficulty in chewing, facial disfigurement, compromise of the airway, and psychological stress [2]. Though there are many factors responsible for ankylosis, trauma and infection are the most common causes [3].

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TMJ ankylosis with micrognathia is often managed as two procedures. Difficulty in mouth opening is managed by arthroplasty and/or reconstruction of temporomandibular joint. Micrognathia secondary to temporomandibular joint ankylosis can be managed by costochondral grafts, mandibular advancement by traditional orthognathic surgical procedures. Costochondral grafts have the advantage of being autogenous material with a cartilaginous articulating surface and potential for growth and adaptation. But the disadvantages are the need for the additional surgical site and unpredictable pattern of growth [4]. Modified Kaban's protocol suggests that distraction osteogenesis is the standard procedure for the correction of the growth defects secondary to temporomandibular joint ankylosis [5]. However, the timing of distraction whether to perform distraction first or arthroplasty first is still a controversy.

So the authors conducted a study to compare treatment outcomes of arthroplasty followed by distraction osteogenesis (AFD) and distraction osteogenesis followed by arthroplasty (DFA) in the management of temporomandibular joint ankylosis.

Patients and Methods

A prospective study was carried at MNR dental college and hospital. Twenty patients with bilateral temporomandibular joint ankylosis, mandibular deficiency and airway obstruction were selected for the study. A total of twenty patients (12 males and 8 females) age ranging from 14 to 31 years were selected, the mean age being 19.4 years. The following were the inclusion criteria for the study.

Inclusion Criteria

1. Temporomandibular joint ankylosis patients with mandibular deficiency more than 7 mm.
2. Radiographic evidence of airway compromise.
3. Medically fit patients for surgery.

Twenty patients were randomly divided into two groups. Group 1 (AFD group) consisted of 10 patients where arthroplasty was performed as first-stage surgery and then distraction osteogenesis was done as second-stage surgery to correct facial asymmetry and third-stage surgery was done for removal of distractors. Group 2 (DFA group) consisted of 10 patients where distraction osteogenesis was performed as first-stage surgery and after consolidation, arthroplasty along with removal of distractors was performed as second-stage surgery. The patients were subjected to a thorough clinical and radiographic evaluation. According to the study protocol, photographs were taken preoperatively and postoperatively. Preoperative and postoperative orthopantomograms (Figs. 1, 2) were taken to assess the bone formation in the distracted site. Preoperative and postoperative lateral cephalograms (Figs. 3, 4) were taken to assess the mandibular advancements and improvements in pharyngeal airway. The preoperative radiographic tracings done were compared with postoperative radiographs on 3rd, 6th, and 12th months, and the technique was assessed.

Lateral cephalometric studies were performed to assess the dimensions of the mandibular body and ascending ramus. Osseous changes which were produced postoperatively were compared to that of preoperative values by using Burstone's analysis [6]. The ramus height was measured from porion (Po) to gonion (Go) and the anteroposterior length of the body of the mandible is measured from gonion (Go) to menton (Me) (Fig. 5). Porion was used as a reference point for the ramus height measurement because the patients who were treated for temporomandibular ankylosis by arthroplasty, lacked a condylion point. The upper airway is measured from the base of the tongue to the wall of the pharynx. The lower airway is measured from the point where the airway is crossed by the mandibular border to the wall of the pharynx (Fig. 6) [7].

For arthroplasty, a standard preauricular incision was given and interpositional arthroplasty was performed with temporalis myocutaneous flap. For distraction osteogenesis, an intraoral incision was given when only corpus lengthening was required. An extraoral submandibular incision was given when both vertical ramus height and corpus lengthening were indicated. Intraoral distractors were used in all cases. The activation arm was positioned in the buccal vestibule when corpus lengthening alone was done. When angle or ramus lengthening was made, the activation arm was positioned extra orally on the cheek to facilitate easy activation. The pitch of the screw was 0.5 mm which means, one complete rotation makes 0.5 mm advancement. The standard distraction protocol was followed. The distractors were removed after a consolidation period of 3 months.

Results

There was an overall improvement in aesthetics in both the groups; both soft and hard tissue enhancements were noted. There was considerable improvement in the airway in both DFA and AFD groups.

The results are tabulated in Table 1.

The mean preoperative mouth opening was 0 mm in both the groups. There was an immediate improvement in the mouth opening in the AFD group, while in DFA group, improvement in mouth opening was achieved in the 4th

Fig. 1 OPGs of AFD group

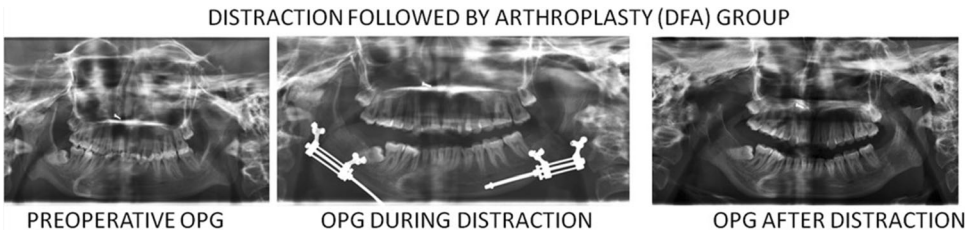

Fig. 2 OPGs of DFA group

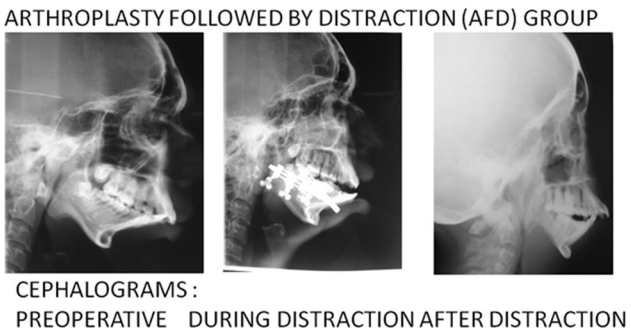

Fig. 3 Lateral cephalograms of AFD group

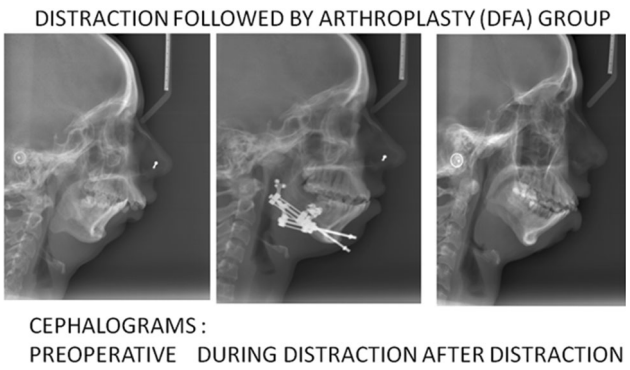

Fig. 4 Lateral cephalograms of DFA group

month. The mean mouth opening in AFD and DFA groups at the end of 6 months was 33.5 mm and 34.8 mm and at the end of 12 months, it was 31.1 mm and 34.1 mm, respectively. The mean time taken to achieve a mouth opening of 35 mm in the AFD group was 18 days, while in the DFA group, it was 95 days.

The mean preoperative overjet in AFD & DFA groups was 9.3 mm and 9.1 mm, respectively. The overjet slightly increased in the AFD group to 10.3 mm due to decrease in

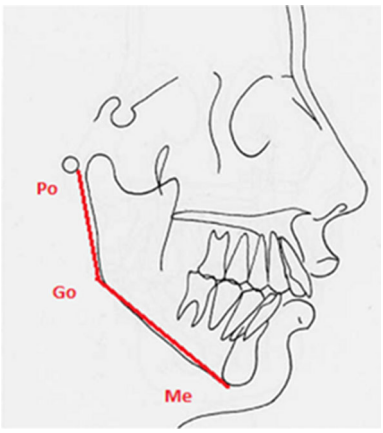

Fig. 5 Skeletal parameters evaluation

Fig. 6 Upper and lower pharyngeal airway evaluation

Table 1 Comparative evaluation of AFD and DFA groups

Parameter	AFD				DFA			
	Pre op	3 mon	6 mon	12 mon	Pre op	3 mon	6 mon	12 mon
Interincisal distance (MM)	00	34.2	33.5	31.1	00	00	34.8	34.1
Over jet (MM)	9.3	10.3	3.1	3.9	9.1	1.7	2.6	3.2
Corpus length (MM)	52.2	52.2	60	59.4	51.6	60.2	60.0	59.8
Ramus height (MM)	48.6	48.6	56.4	55.8	47.2	56.4	56.2	56
Upper airway (MM)	5.4	5.0	11.0	10.6	4.5	11.6	11.4	11.2
Lower airway (MM)	5.1	4.8	9.2	8.9	4.3	10.4	10	9.8

Pre op preoperative, *Mon* months, *MM* millimetres

the vertical ramus height and rotation of the mandible. The mean overjet in AFD & DFA groups decreased to 3.1 mm and 2.6 mm at 6 months postoperative period and to 3.9 mm and 3.2 mm at 12 months postoperative period. In the study, overjet remained more stable in the DFA group.

The mean preoperative corpus length in AFD and DFA groups was 52.2 mm and 51.6 mm, respectively. At the end of 3rd month, the corpus length remained the same in the AFD group, but in DFA it increased drastically to 60.2 mm. The mean corpus length in AFD and DFA groups increased to 60 mm and 60.2 mm at 6 months postoperative period and to 59.4 mm 59.8 mm at 12 months postoperative period.

The mean preoperative ramus height in AFD and DFA groups was 48.6 mm and 47.2 mm, respectively. At the end of 3rd month, the ramus height remained the same in the AFD group, but in DFA it increased drastically to 56.4 mm. The mean ramus height in AFD and DFA groups increased to 56.4 mm and 56.2 mm at 6 months postoperative period and to 55.8 mm and 56.0 mm at 12 months postoperative period.

The mean preoperative upper airway in AFD and DFA groups was 5.4 mm and 4.5 mm, respectively. At the end of 3rd month, the upper airway decreased to 5.0 mm in the AFD group, but in DFA it increased to 11.6 mm. The mean upper airway in AFD and DFA groups increased to 11.0 mm and 11.4 mm at 6 months postoperative period and to 10.6 mm and 11.2 mm at 12 months postoperative period.

The mean preoperative lower airway in AFD and DFA groups was 5.1 mm and 4.3 mm, respectively. At the end of the 3rd month, the lower airway decreased to 4.8 mm in the AFD group, but in DFA it increased to 10.4 mm. The mean upper airway in AFD and DFA groups increased to 9.2 mm and 10 mm at 6 months postoperative period and to 8.9 mm and 9.8 mm at 12 months postoperative period.

There was no statistically significant difference in the parameters of the study between the two groups, but the results were more stable in the DFA group.

Discussion

Temporomandibular joint ankylosis is a condition in which there is a fusion of the mandibular condyle to the glenoid fossa of the temporal bone. When it occurs at a young age, it affects the growth of the facial skeleton resulting in retrognathic mandible, facial asymmetry, deviated chin, midline shift, occlusal cant, crowding of the teeth, and unerupted teeth. Decreased mouth opening also leads to poor oral hygiene, dental caries, and periodontal diseases. Retrognathic chin and jaw also leads to reduced dimensions of the airway and some of these patients may have sleep apnoea [8]. There are several fundamental elements for successful treatment for temporomandibular joint ankylosis and related dentofacial deformity: the establishment of adequate mouth-opening range, complete removal of the ankylotic block to prevent reankylosis, and establishment of balanced facial appearance after surgery. To achieve these goals, various approaches such as distraction osteogenesis have been suggested as a protocol.

Surgeons attempted simultaneous correction of all deformities by performing distraction at the time of ankylotic mass removal. The pitfalls of this approach suggested were that after the release of the ankylotic block, changes in the mandibular position cannot be completely controlled during the distraction period. During the distraction, the proximal segment moves towards the glenoid fossa and become positioned closer to the articular surface, which can result in reankylosis if adequate physiotherapy was not applied. However, performing active physiotherapy during the distraction period was not easy because of postsurgical pain and discomfort. For these reasons, a staged operation for temporomandibular joint ankylosis comprising ankylosis release as the first surgery, and distraction osteogenesis as the second surgery has been proposed [9–11].

The authors found that the control over the proximal segment after arthroplasty was tough and it was easy to distract the mandible forward with a stable proximal segment. The protocol shifted from arthroplasty first to distraction first, followed by arthroplasty [12, 13].

After the introduction of distraction osteogenesis for post ankylotic mandibular lengthening, there were many studies which reported the successful outcomes by using the technique. But there were reports of controversies about the timing of distraction. So the authors conducted a prospective study to assess the outcomes of the timing of the distraction osteogenesis in mandibular deficiencies secondary to temporomandibular joint ankylosis.

The authors found that in both the groups there was an overall improvement in all the parameters of the study. However, the control of the proximal segment was superior in the DFA group over the AFD group. Similar results were proposed by Zhu et al. [14] that one stage surgical treatment is indicated for patients with mild to moderate preoperative malocclusion and skeletal deformities. Staged treatment, on the other hand, is better suited to achieve a more stable postsurgical outcome in patients with severe dentofacial deformities. This is in accordance with our DFA group of patients showing the advantages of staged treatment; it promotes early postoperative engagement in active mouth-opening exercise, allows sufficient time to monitor malocclusion, and may reduce the chances of reankylosis. In AFD approach, authors have suggested that after the release of the ankylotic block, changes in the mandibular position cannot be completely controlled during the distraction period. During distraction, the proximal segment can move towards the condylar fossa and become positioned closer to the articular surface, which can result in reankylosis if adequate physiotherapy is not applied. However, it is not easy to perform active physiotherapy during the distraction period because of postsurgical pain or discomfort.

In the present study time taken for achieving 35 mm mouth opening in the AFD group was 5 days, whereas in the DFA group it was 95 days. All through the study, the skeletal parameters were more stable at 12 months in the DFA group compared to the AFD group. In the study, the AFD group reported a mean increase of 7.2 mm in corpus length with an overall improvement of 13.7% at one-year follow-up period. While that of DFA group reported a mean increase of 8.3 mm and an overall improvement of 16.4% in corpus length at one year follow-up period. So in the study, a slightly more increase in corpus length is seen in the DFA group postoperatively compared to the AFD group.

During the distraction in the AFD group, it was difficult to control the small proximal segment. Gholamreza shirani [15] proposed an SH device to control the proximal segment.

In the study, the AFD group reported a mean increase of 7.2 mm in ramus height with an overall improvement of 14.8% at one-year follow-up period. While that of DFA group reported a mean increase of 8.8 mm in ramus height with an overall improvement of 18.6% at one-year follow-up period. So in the study, a slightly more increase in ramus height is seen in the DFA group postoperatively compared to the AFD group. The airway happens to be an important parameter in the management of temporomandibular joint ankylosis. Almost all such patients have a compromised airway. Quantitative assessment of the upper airway showed improvement of 96% in the AFD group and 148% in the DFA group. Quantitative assessment of lower airway showed improvement of 74.5% in the AFD group and 127% in the DFA group. Neelam [16] proposed a polysomnographic study where the 2 stage surgical technique of initial bilateral distraction followed by arthroplasty showed promising results.

Neelam et al. [17] also suggest that in patients with the triad of temporomandibular joint ankylosis, micrognathia, and obstructive sleep apnoea, distraction before arthroplasty prevents potential life-threatening complications like bradycardia and apnoea hypopnoea. This is in accordance with the study where 6 patients in the AFD group complained of increased snoring and shortness of breath at night during sleep. This may be attributed to the absence of a posterior stop of condyles thereby falling back of mandible during rest or sleep. Other authors found similar results in the management of obstructive sleep apnoea that the prearthroplastic distraction is beneficial [18].

There were three surgeries required for the completion of the treatment in the AFD group. Arthroplasty was performed as first-stage surgery, then distraction osteogenesis was done as second-stage surgery to correct facial asymmetry, and third-stage surgery was done for removal of distractors. In DFA group, distraction osteogenesis was performed as first-stage surgery and after consolidation, arthroplasty along with removal of distractors was performed as second-stage surgery. So in DFA group, only two surgical procedures were required for the final outcome unlike three surgical procedures which were required in AFD group. In the DFA group, during both the surgical procedures, there was difficulty in intubation as there was completely restricted mouth opening, whereas in AFD Group, there was difficulty in intubation only in the first-stage surgery as the mouth opening was established after the first surgical procedure.

Conclusion

Distraction osteogenesis has a beneficial effect on the harmony of craniofacial complex and also on temporomandibular articulation. Both AFD and DFA groups are effective in the correction of facial asymmetry and in improving function. DFA has a better control over the proximal segment and shorter management period; patient

compliance is extremely essential. In AFD, a longer management period is required, control of distraction is difficult, multiple surgeries are required and risk of reankylosis persists.

In the present study improvement in facial asymmetry was noticed in both DFA and AFD groups. This is primarily because of the overall improvement seen in terms of corpus length, ramus height, airway, and mouth opening. Despite fewer complications, distraction osteogenesis prior to arthroplasty gave better results than arthroplasty followed by distraction osteogenesis. However, a more detailed study using a large homogenous sample with long-term follow-up showing a statistically significant difference is required to substantiate the result. We need to include adequate numbers in samples, possibly a multicentre study, treated in a similar way, and documented after growth cessation. The protocol for follow-up and evaluation should be standardized to have meaningful conclusions.

Compliance with Ethical Standards

Conflict of interest Dr. G Harsha, Dr. Aditya Mohan Alwala, Dr. Ramesh K, Dr. Srilatha Tunkimetla, Dr. Rathod Prakash, and Dr. Zainuddinelyaskhan Y declare that there are no conflicts of interest.

Ethical Clearance Obtained from Institutional Ethical Committee.

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