Comparison Between Two Techniques for the Treatment of Mandibular Subcondylar Fractures: Closed Treatment Technique and Transoral Endoscopic-Assisted Open Reduction

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Abstract

Purpose The endoscopic-assisted technique for the treatment of subcondylar fractures has been used successfully and its acceptance develops as more surgeons gain experience. We present the short term results of this technique in a randomized prospective clinical trial.

Methods and Materials A total of 40 patients with mandibular subcondylar fracture were included in our study in two groups randomly. Patients of first group were treated by closed treatment technique and patients of second group by transoral endoscopic-assisted open reduction. All patients were followed for minimum of 12 weeks and occlusion, Mandibular Anterior Opening (MAO), mandibular deviation, and posterior ramal height were assessed.

Results In the endoscopic group the MAO was significantly greater and mandibular deviation was lesser at 2nd and 4th week of follow up. Posterior ramal height showed significant increase in the endoscopic group rather than closed treatment group.

Conclusion The transoral endoscopic-assisted technique is a reliable and successful technique to address subcondylar fractures. The patients who were treated by this technique showed better results in the fields of mandibular function and patient satisfaction and comfort, although it is time consuming and needs expensive instruments.

Keywords Mandibular subcondylar fracture · Endoscopic assisted reduction · Closed treatment techniques

Introduction

The topic of condylar injury has generated a lot of discussion and controversy in the field of maxillofacial trauma [1–4] and the treatment of subcondylar fracture is one of these controversies. The existence of this controversy is based on the positive and negative aspects of open techniques and closed techniques [1]. Mandibular condylar injuries are common among populations and their prevalence in different societies have been reported between 9 and 45 percent based on different studies [5, 6]. By the conventional open techniques (preauricular, retromandibular, submandibular and endaural approaches) we can achieve an anatomic and favorable reduction, so function of the TMJ can be rapidly achieved and better results concerning function have been reported [1]. By this technique, osteosynthesis is done and better bone to bone fusion is achieved but there is higher risk of complications such as facial nerve injury and presence of visible scar on the face. Also, salivary fistulas have been reported [1, 6]. Closed treatment technique is a more appropriate designation than closed reduction, because in most cases no “reduction” of the fracture is performed [7], (include intermaxillary fixation and elastic therapy) will not show aforementioned complications of open techniques, but since one cannot achieve an anatomic reduction the function of the TMJ can take longer time to improve and can be compromised.

Possible complications are shortening of the ascending mandibular ramus, open bite, malocclusion, decreased Mandibular Anterior Opening (MAO), lateral deviation of

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the mandible during opening, avascular condylar necrosis and so on [1–4]. Presently closed treatment is the most widely used method even for treatment of dislocated condylar fractures because experimental studies have shown that the conservative method of treating these fractures is apparently complication free and has satisfactory results [1, 3, 8].

Improvements in instrumentation, particularly endoscope techniques have made minimally invasive approaches to the maxillofacial skeleton possible [2, 9, 10]. Endoscope has been used successfully for the treatment of TMJ (arthroscopy), salivary glands disease and skull base surgery since many years [11–13]. Transoral endoscopic-assisted open reduction is used to cumulate advantages of both open and closed techniques [14]. The advantages of endoscope techniques are limited transoral incision, superior visibility for the surgeon, minimal risk of facial nerve palsy and no need for dissection of the masseter muscle [4].

Despite these advantages, endoscope technique has not become popular because of its steep learning curve, time consumption and need for special instruments [1–4]. On the other hand, lack of a prospective clinical trial with high level of evidence forced us to design a study to compare the results of subcondylar fractures treatment by two techniques: (1) closed treatment and (2) transoral endoscopic-assisted open reduction.

Materials and Methods

The local ethics committee of the university approved the study design, and informed consent was obtained from all the patients. The patients with subcondylar fractures presented to the maxillofacial surgery department of Ahwaz Imam Khomeini hospital (from May 2011 to Aug 2012) randomly were included in two groups in this randomized controlled trial. All the following conditions were required as inclusion criteria:

1. Displaced unilateral mandibular subcondylar fracture
2. Deranged occlusion
3. Females aged more than 15 years and males aged more than 16 years

There were three exclusion criteria for our study:

1. Patients with maxillary fracture
2. Angle fracture on the side of subcondylar fracture
3. Absolute indication of open reduction

Each group consisted of 20 patients. The first group was named closed treatment group and the second group was named endoscopic group.

In all patients, subcondylar fracture and degree of displacement were assessed by orthopantomography and

Fig. 1 Preoperative orthopantomography to determine Go and Gln points

mandibular postero-anterior radiography before surgery. We identified the highest point of the glenoid fossa on the side of fracture in panoramic radiography which was named Gln. Then we drew tangents of the lower border and the distal border (ascending ramus) of the mandible. The angle formed by these two lines was named external gonial angle. Then we drew the line of intersection of external gonial angle, and the point produced by reaching this line to the mandibular angle region is Go (Fig. 1). The distance between Gln and Go (posterior ramal height) was measured to compare by follow up panoramic.

Surgical Technique

Closed treatment group The procedure was done under general anesthesia and on the operating table. First we set the Erich arch bars on the both jaw arches and if concomitant mandibular fractures other than subcondylar were present, Open Reduction and Rigid Fixation of these fractures in the proper dental occlusion were performed in the usual fashion by miniplates (using non compression 2.0 AO/ASIF miniplates—Synthes AG, Solothurn, Switzerland).

Finally after achieving occlusion with manipulation, we placed heavy elastic bands (3/16 inch–6.5 oz). After this period, we changed the elastic bands to light type (3/16 inch–

2.5 oz). Active physiotherapy was started at the end of 4th week.

Endoscopic group Like in the previous group, we treated the concomitant mandibular fractures first rigidly, and then addressed the subcondylar fractures. A vertical incision was made following the anterior border of the ascending ramus of the mandible. The subperiosteal dissection was performed widely at the lateral aspect of the ramus into posterior border to allow for an optical cavity to be created.

Then we inserted the standard 30° endoscope (Karl Storz, Tuttlingen, Germany) with a Xenon light source to the optical cavity to evaluate the location of fractured region, degree of segments overlap and so on (Fig. 2). Then the fractured segments were reduced by pulling down the distal segment and manipulation of condylar segment and the adequacy of the reduction was judged by endoscope. We used a right-angled drill screw driver (Synthes 90° screw driver—Synthes company—Switzerland) for fixation of the fracture line using miniplates (non compression 2.0 AO/ASIF miniplates—Synthes company—Switzerland) with at least two holes and screws at either sides of fracture line (Fig. 3). After the first plate insertion, we checked stability of fragments and if it was incomplete, then the second plate was inserted.

After operation, patients were placed on light elastic bands (3/16 inch–2.5 oz) for 1 week and then mobilized with physiotherapy exercises.

All patients (groups one and two) were followed up 1, 2, 4, 6 and 12 weeks postoperation.

At the follow up sessions we assessed dental occlusion, MAO, mandibular deviation on opening and complications of surgery (facial nerve weakness, and presence of infection). In order to assess the mandibular deviation we measured deviation of the mandible from midline during opening.

At the last follow up session (end of 12 weeks) we assessed patients' satisfaction and posterior ramal height (Gln–Go distance). To address the patients' satisfaction, the patients were asked to give a subjective opinion of treatment. In order to measure the postoperation Gln–Go indicator, we used the final panoramic X-ray performed at the 12th week of follow up (Fig. 4).

The statistical evaluation of the findings was performed with the help of the SPSS (Statistical Package for Social Sciences) software.

Results

A total of 40 patients with subcondylar fracture were included in two groups randomly and treated by closed treatment technique and endoscopic-assisted open reduction.

Fig. 2 Evaluation of subcondylar fracture site by endoscope

Fig. 3 Endoscopic evaluation of subcondylar fracture reduction and fixation

Data Related to Group One (Closed Treatment): (Table 1)

The mean age was 32.45 ± 12.03 (min = 17, max = 59) years with 14 males (70 %) and 6 females (30 %).

The most concomitant fracture was contralateral parasymphysis fracture (5 cases) (25 %), and 8 cases (40 %) had isolated subcondylar fracture with no concomitant fracture.

At the last follow up session (end of 12 weeks), there were 3 instances of disturbed occlusion (15 %) that were believed to be minor and were tolerated by those patients easily. The

Fig. 4 Postoperation panoramic x-ray

Table 1 Summary of the study samples in the closed reduction group and acquired results at the end of 12 weeks

Patient number	Sex/age	Disturbed occlusion	MAO (mm)	Mandibular deviation (mm)	Gln–Go (preop) (mm)	Gln–Go (at the 12th week) (mm)	Gln–Go changes from preop to postop (mm)	Concomitant fractures
1	M/23	–	40	6	61	62	1	–
2	M/26	+	37	3	69	70	1	–
3	M/50	–	39	0	64	72	8	Bilat. Body
4	F/55	–	42	2	54	54	0	Contra. parasymphysis
5	F/39	–	42	0	50	53	3	Contra. Body
6	M/42	–	33	0	58	58	0	–
7	M/17	–	39	0	51	55	4	Contra. Parasymphysis
8	M/21	–	43	3	45	46	1	Ipsi. parasymphysis
9	M/31	+	25	0	51	55	4	Contra. body and parasymphysis
10	F/24	–	41	4	59	60	1	–
11	F/33	–	37	0	68	68	0	–
12	M/26	–	41	0	78	78	0	–
13	M/29	–	39	0	58	59	1	Contra. Angle
14	M/59	–	40	0	72	72	0	Ipsi. Body
15	M/23	+	35	0	60	60	0	Bilat. Body
16	M/21	–	39	0	62	63	1	Contra. Body
17	M/36	–	37	0	64	64	0	Contra. parasymphysis
18	F/36	–	46	0	59	60	1	Contra. parasymphysis
19	M/39	–	39	2	49	52	3	–
20	F/19	–	44	1	43	43	0	–

F female, M male, MAO Maximum Anterior Opening, Bilat. Bilateral, Ipsi ipsilateral, Contra contralateral

means of MAO were 28.2 ± 5.45 , 34.75 ± 5.84 , 36.75 ± 5.77 and 38.9 ± 4.45 (min = 25, max = 46 at the last follow up session) mm, at the end of 2nd, 4th, 6th and 12th week postoperatively. The means of mandibular deviation were 2.1 ± 2.44 , 1.55 ± 1.73 , 1.05 ± 1.73 and 1.05 ± 1.73

(min = 0, max = 6 at the last follow up session) mm, at the end of 2nd, 4th, 6th and 12th week postoperatively. Other functions of TMJ were not impaired in any patient. The mean Gln–Go changes showed 1.45 ± 2.03 (min = 0, max = 8) mm increase.

As subjective evaluation, patients complained of difficulty in nutrition, oral hygiene maintenance, breathing and speech, limitation of jaw movement and pain on the condylar fracture side in particular during heavy elastic therapy period.

During the first week of surgery one patient (5 %) presented with pus at the site of surgery (left body) which was not related to the subcondylar fracture. He was treated by drainage and irrigation and antibiotic therapy with no more complication.

Data Related to Group Two (Endoscopic): (Table 2)

The mean age was 34.25 ± 13.26 (min = 17, max = 58) years with 16 males (80 %) and 4 females (20 %).

The most concomitant fracture was contralateral parasymphysis fracture (3 cases) (15 %), and 10 cases (50 %) had isolated subcondylar fracture.

Average operating time from ramus incision start to completion of plate fixation for the subcondylar fracture was 80.35 ± 25.37 (min = 47 and max = 125) minutes.

At the first follow up session (end of 1 week), there was 1 instance of disturbed occlusion (5 %) which was minor and addressed by continuing elastic therapy after first week and at the end of 12 weeks we found acceptable occlusion in that patient.

The means of MAO were 35.30 ± 4.62 , 38.5 ± 4.04 , 39.1 ± 3.95 and 41.25 ± 2.97 (min = 36, max = 46 at

the last follow up session) mm, at the end of 2nd, 4th, 6th and 12th week postoperatively. The means of mandibular deviation were 0.75 ± 1.44 , 0.45 ± 1.09 , 0.35 ± 0.87 and 0.25 ± 0.78 (min = 0, max = 3 at the last follow up session) mm, at the end of 2nd, 4th, 6th and 12th week postoperatively. Other functions of TMJ were not impaired in any patient. The mean Gln–Go changes showed 5.8 ± 3.41 (min = 2, max = 12) mm increase.

As a subjective evaluation, patients complained of pain and edema on condylar surgical area especially during 1st and 2nd weeks.

Just the day after surgery we found two patients (10 %) with facial nerve weakness due to subcondylar surgery. After 2 weeks all of these patients had recovered and there was no facial nerve disturbance due to surgery. There were no instances of infection in the surgery site.

Comparison

We analyzed measured MAO and mandibular deviation at the end of 2, 4, 6 and 12 weeks between the two groups by means of Mann–Whitney test and these differences were statistically significant at 2nd and 4th weeks. After 4 weeks in the closed treatment group results improved and difference was not significant.

Table 2 Summary of the study samples in the endoscopic group and acquired results at the end of 12 weeks

Patient number	Sex/age	Disturbed occlusion	MAO (mm)	Mandibular deviation (mm)	Gln–Go (preop) (mm)	Gln–Go (at the 12th week) (mm)	Gln–Go changes from preop to postop (mm)	Concomitant fractures
1	M/58	—	40	0	45	55	10	Bilat. Body
2	M/29	—	42	0	59	61	2	Contra. parasymphysis
3	M/40	—	43	0	53	59	6	—
4	F/39	+	45	0	49	61	12	Contra. Angle
5	M/49	—	45	0	61	69	8	—
6	F/34	—	40	2	68	68	0	—
7	F/18	—	37	0	75	77	2	—
8	M/17	—	46	0	69	79	10	Contra. parasymphysis
9	M/28	—	45	0	58	61	3	Contra. Body
10	M/33	—	44	0	67	69	2	—
11	M/36	—	42	0	64	72	8	—
12	F/35	—	36	3	79	80	1	Contra. Angle
13	M/21	—	39	0	62	66	4	Ipsi. Body
14	M/18	—	41	0	54	59	5	Contra. Body and parasymphysis
15	M/17	—	44	0	64	72	8	—
16	M/33	—	40	0	58	65	7	Ipsi. parasymphysis
17	M/52	—	37	0	51	58	7	—
18	M/49	—	39	0	60	65	5	—
19	M/23	—	41	0	53	59	6	—
20	M/56	—	39	0	42	52	10	Contra. parasymphysis

F female, M male, MAO Maximum Anterior Opening, Bilat. Bilateral, Ipsi ipsilateral, Contra contralateral

Finally comparing Gln–Go changes from preoperation to postoperation by means of non parametric test (Mann–Whitney) revealed that the mean changes in the endoscopic group were higher than closed treatment group and P value of 0.00 indicates the significance statistically. On the other hand, we compared preop Gln–Go and postop Gln–Go based on each treatment group by Wilcoxon test, and in the closed treatment group and endoscopic group 0.02 and 0.00 were achieved as P value respectively, both of which are significant.

Discussion

Although traditional approaches to the subcondylar fractures are reliable, the presence of visible scars, technical problems and complications such as facial nerve palsy have led to the relatively recent development of endoscopic approaches to these injuries.

Although endoscopic approaches have steep learning curves and are time consuming, the surgeon could overcome these problems by improved training and experience. Ducic [15] has presented mean operating time of 32 versus our 80 min.

Meuller et al. [16] noted that traditional treatment of subcondylar fractures with maxillomandibular fixation often results in a malreduction and significant functional and aesthetic sequelae, including facial asymmetry, decreased jaw opening, and potential for late derangements of the TMJ. Thus the authors strongly advocated endoscopic repair of adult condylar neck and subcondylar fractures that demonstrate displacement or dislocation and have adequate proximal bone stock to accept miniplate fixation [16].

Based on Buschang's study in 1999, the peak of adolescent mandibular condylar growth spurt occurs in 12.2 and 14.3 years for females and males respectively and then in 1 or 2 years the growth velocity decreases incrementally. So we selected age groups of more than 15 years for females and more than 16 years for males, to decrease as much as possible the effects of condylar growth as an interventional factor [17].

In our study we found in the closed treatment group (traditional treatment) three patients and in the endoscopic group 1 patient with disturbed occlusion and for none of them reoperation was necessary. Although disturbed occlusion is more in the closed treatment group but the difference is not statistically significant. On the other hand 3 of 4 disturbed occlusions were in patients with concomitant fractures which makes it difficult to diagnose which one is the reason of disturbance.

The average MAO and mandibular deviation at 2nd and 4th weeks follow up in the endoscopic group was higher and statistically significant but this difference was not significant at

6th and 12th weeks. We concluded due to anatomic reduction, fixation and sooner physiotherapy, functional restore of the TMJ in short term was predictable and reliable in endoscopic group. By start of active physiotherapy in closed treatment group (after 4 weeks), TMJ function and bone consolidation improved and difference between the two groups decreased. Also a study with long term follow up is advocated.

We used Gln–Go as an indicator of posterior ramal height. Our study showed that the mean value of Gln–Go changes from preop to postop which was greater in the endoscopic group and the difference between the two groups was statistically significant ($P = 0.00$). It means endoscopic technique has better short-term effect to restore normal posterior ramal height of each patient and it is probably one of the factors affecting the improved TMJ function, higher MAO and lower mandibular deviation during opening achieved by endoscopic technique. We believe facial soft tissue coverage compensates posterior ramal height decrease in closed treatment group. On the other hand, cooperation of masticatory muscles, extrusion and intrusion of teeth compensate occlusal changes in this group.

Cho-lee et al. [1] treated 3 patients with subcondylar fractures of the mandible by an endoscopically-assisted transoral approach. After 6 months follow-up, postsurgical radiographs revealed good reduction in fractures in all three cases and no sign of temporomandibular dysfunction [1].

In our study we found two patients with facial nerve weakness just after the surgery. We consider two possible reasons: First, use of right angled screw driver needs soft tissue flap to be elevated much more than only optical cavity and transcutaneous stab incision (the technique used by Ducic [15], and this causes more retraction of buccal flap which performs pressure on the buccal soft tissue and facial nerve branches. Second, excessive pressure on the retromandibular soft tissue and parotid gland during manipulation can cause facial nerve damage. This complication has been recovered in 1 week.

Choi and et al. [18] reported one patient with transient total facial nerve paralysis after endoscopic-assisted management of subcondylar fracture. In their case, no damage to the facial nerve was observed intraoperatively, but the patient had total facial paralysis, immediately postoperatively. At long term follow up, the facial nerve function was recovered well within 6 months [18].

Arcuri et al. [19] based on their data records from 14 patients who underwent surgical repair of subcondylar fractures by transoral endoscopic-assisted technique showed 4 complications experienced by 4 different patients: (1) arterial hemorrhage, (2) facial nerve injury, (3) nonunion, (4) partial condylar reabsorption.

Gonzalez-Garcia [20] used angulated drills and screw-drivers in two subcondylar patients but no damage to the facial nerve was observed.

Generally, patient's satisfaction was higher in the endoscopic group. Probably this depends on following factors which are advantages of endoscopic open reduction versus closed treatment: Using no IMF and heavy elastic band, easier nutrition, speech and breathing, improved oral hygiene and jaw movement, and no need for long-term physical therapy.

Conclusion

The transoral endoscopic-assisted technique is a reliable and successful technique to address the condylar and subcondylar fractures. Patients treated by this technique showed superior results in the field of mandibular function although it is time consuming and needs expensive instruments. So we advocate use of this technique for adult subcondylar fractures in particular when patient's satisfaction and comfort is a great concern.

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