Available online at www.medicinescience.org

ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2022;11(4):1702-710

# Long term results from the treatment of sub-condylar region fractures of the mandible

**Bilge Kagan Aysal[1], Ozlem Colak[1], Ilker Uscetin[1], Batibey Batmaci[1], Caner Ali Ilhan[1], Defne Gurbuz[2]**

*[1]Prof.Dr.Cemil Tascioglu City Hospital, Department of Plastic and Reconstructive Surgery, Istanbul, Türkiye*
*[2]Prof.Dr.Cemil Tascioglu City Hospital, Department of Radiology, Istanbul, Türkiye*

Received 31 October 2022; Accepted 06 November 2022
Available online 29.11.2022 with doi: 10.5455/medscience.2022.10.228



**Abstract**

The Sub-condylar region is a common place for mandible fractures and these fractures can be managed by open reduction and internal fixation techniques, or only inter-maxillary fixations. The aim was to reveal the effects of healing of these fractures on clinical and radiologic findings. This is a clinical study including 15 patients. All patients had unilateral sub-condylar fractures and patients who had bilateral sub-condylar fractures, intra-articular fractures, or displaced mandible fractures that were located on another subpart were excluded. Clinical assessments include occlusion, maximum mouth opening at an interincisal distance, deviation of the mandible with mouth opening, and general oral and health assessment index. Radiologic assessments include the heights of the condyles and rami + condyles, and the distances between the mandible anguli and cranial base. Statistical tests have been performed. The patients' ages ranged between 9 and 70 years (mean:28.1±15.4). Follow-up period ranged between 6 and 74 months (mean: 28.3±27.2). 13 patients had normal occlusions. The mean maximum mouth opening was 4.3±0.69 centimeters. 11 patients had a mean mandibular deviation of 0.26±0.27 centimeters with mouth opening. Clinical effects of the fracture and healing period can be accepted as quite satisfying in both clinical and radiologic means with either treatment options including open reduction internal fixations and IMF/Arch-Bar-only techniques. Long-term results of sub-condylar region fractures are quite acceptable with a high level of quality of life.

**Keywords:** Arch bar, condyle fracture, intermaxillary fixation, maxillomandibular fixation, open reduction internal fixation, subcondyle fracture

## Introduction

The location of the mandible makes it vulnerable to fractures and surgeons have been repairing mandibular fractures for many decades [1-3]. Before the introduction of plates and screws into the maxillofacial region, we used to repair the fractures with open reduction and fixation with wiring techniques [4, 5]. After the presentation of rigid fixation techniques in cephalic region fractures [6-8], reaching more stable internal fixations became standardized.

Assaults and motor vehicle accidents are the two of most important etiologic causes [9]. After applied force comes from another person or a motor vehicle and passes through the mandible, the most common sites for fractures become the body and the angle with 32% and 28%, respectively [10]. Fractures of the condyler site were reported between 25-35% [11-13], however a direct force to the jaw results in a fracture in the condylar site in 72% of the patients based on poor elasticity of the neck [14].

The sub-condylar site is an important region for mandibular fractures. With fractures, shortening of the ramus, deviation of the jaw with mouth opening and malocclusion are usually encountered. However, surgical exposure of this site is quite difficult with the branches of the facial nerve passing over the condylar neck and the maxillary artery passing just beneath it. This difficulty often influences surgeons in the decision making process and causes controversies [15]. Treatment options include intermaxillary fixation (IMF) after closed reduction, open reduction and internal fixation (ORIF) and endoscopic-guided reduction and internal fixation (ERIF) [16].

Although technically difficult, ORIF can be accepted as the gold standard in many cases, and IMF after closed reduction is an important and a very commonly used option. The long term results of both techniques on mouth opening capacity and mandibular deviation with movement of the jaw, occlusion, and heights of the

***Corresponding Author:** Bilge Kagan Aysal, Prof.Dr.Cemil Tascioglu City Hospital, Department of Plastic and Reconstructive Surgery, Istanbul, Türkiye
E-mail: bilgekaganaysal@gmail.com

rami and condyles were investigated in the presented study.

## Materials and Methods

### Patients

Ethical committee approval was obtained before the study (Prof Cemil Tascioglu City Hospital Clinical Ethical Committee 21.03.2022-136). The records of Prof Cemil Tascioglu City Hospital, Deparment of plastic, reconstructive and aesthehtic surgery were checked. Patients with mandibular fractures in the unilateral subcondylar regions whose treatments had been performed between January 2016 and December 2021 were included in the presented study. The demographics of the included patients were outlined in Table 1. The procedures were carried out under general anesthesia according to the approach which was outlined under the surgery part of this manuscript.

The patients who had bilateral condylar site fractures, panfacial fractures and concomitant displaced mandibular fractures other than condylar regions were excluded from the study.

The patients who had been eligible for this study were accepted again for late term clinical and radiological assessments.

### Surgery

All of the surgical procedures were carried out in the operating theatre under general anesthesia.

In the IMF group, the mandibles were stretched to the maximum mouth opening. The fractures were reduced in closed fashion by outer pressure in lateral overriding condyles and by intraoral finger pressure in medial overriding or medially deviated condyles. There were no laterally deviated condyles in this group. Normal occlusions were achieved and Erich Arch Bars or IMF screws were applied. Barrel bandages were put in during the recovery period after anesthesia and rubber bands were put to achieve normal occlusion after the placement of a posterior bite block. IMFs were left on for four weeks and physical therapies begun afterwards to avoid ankyloses.

In the ORIF group, the mandibles were stretched again to the maximum mouth openings and four IMF screws were placed on the anterior surfaces of both jaws. Normal occlusions were achieved by wiring through the IMF screws. Retromandibular incisions were used in low subcondylar fractures and preauricular incisions were used in high subcondylar fractures. After incision of the superficial musculoaponeurotic system (SMAS) layer, the parotid capsules were incised vertically. Meticulous dissections were performed in the superficial lobes of parotid glands and the branches of the facial nerves were exposed. Deeper dissections were performed between the upper buccal and zygomatic branches in the retromandibular incisions, and between the zygomatic and frontal branches or posterior to the frontal branch in the preauricular incisions. The two incisions were combined when the condyles were medially deviated more than 30 degrees. After exploration, the fracture sites were reduced and two mini titanium plates were placed for internal fixations.

### Assessment Methods

Patients were followed up at least six months after their operations had been performed. The patients were evaluated by clinical and radiologic means.

Maximum interincisal distances and mandibular deviations after maximum mouth openings were measured clinically and occlusions were evaluated as well.

Patients who had accepted the risks had CT scans for radiologic evaluations. Measurements were taken of both fracture and non-fracture sides of preoperative, early postoperative and late postoperative CT scans. The heights of condyle and ramus, the Gonion point and Frankfort horizontal (FH) plane were used as defined by Qu et al [17]. To sum up, condylar heights were accepted as the distances between the maximum points of the condyles and a horizontal line passing from the lowest points of sigmoid notches (figure 1). Ramus + condyle heights were accepted as the distances between the Gonion points and the maximum points of the condyles. The distances between the anguli and the cranial bases were accepted as the distance between the Gonion points and FH Planes, which is defined as a line passing between the upper point of the external auditory meatus (The Porion) and the lower point of the bony orbitale (The Orbitale).

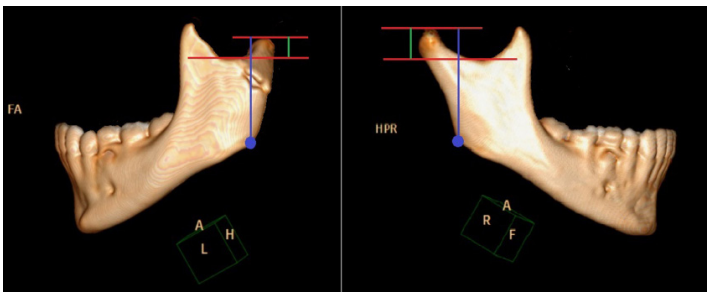



**Figure 1.** Figure outlining the measurements. Left: fracture side, Right: Non-fracture side. Condylar height (green line): the distance between the maximum point of the condyle (short ride line) and a horizontal line passing from the lowest point of sigmoid notch (long red line). Ramus + condyle height (blue line): the distance between the Gonion point (blue circle) and the maximum points of the condyles

### Quality of Life Index

The General Oral Health Assessment Index (GOHAI) [18,19] was adapted and used to reveal the quality of life after treatment have been completed. This is a questionnaire consisting of 12 questions. Scores can be enrolled between 12 and 60, with a higher score meaning more positive levels of health [20]. GOHAI index was outlined in Table 2.

### Statistical Analysis

The software program SPSS (Statistical Package for Social Sciences for Windows 22.0) was used for statistical analysis. Data and values were analyzed by using the Friedman's two-way analysis of variance by ranks and by Mann-Whitney U tests. Outcomes were evaluated at a 95% confidence interval for mean and a 5% significance level. Median, minimum, maximum and interquartile ranges were used in the nonparametric tests. p values below 0.05 were considered significant.

## Results

15 patients were included in the study. Of these, ten accepted the risks of the CT scans and had the scans performed. Gleaned from this, fifteen patients had late term clinical results whereas ten of

them had both clinical and radiological results.

The patients' ages ranged between 9 and 70 years (mean of 28.1 years±15.4). Follow-up period ranged between 6 and 74 months (mean of 28.3 months ±27.2).

### Clinical Results

The clinical results of the patients were outlined in table 1. 13 patients out of 15 had normal occlusions. One of the patients with malocclusions had an ORIF operation, the other had only an intermaxillary fixation with Erich Arch Bars. The maximum mouth opening at interincisal distance ranged between 3.2 and 5.8 centimeters (mean of 4.3 centimeters ± 0.69). With the mouth opening, four had their mandibles in the midline however the remaining ones had mandibular deviations ranging between 0.1 and 1 centimeters (mean of 0.26 centimeters ±0.27). GOHAI index scores ranged between 34 and 59 out of 60 (with a mean of 49.3±5.9).

### Radiologic Results

Radiologic results including preoperative, early postoperative and late postoperative CT scans (Figure 2) were outlined as numeric values in tables 3 to 5, and as percentages in tables 6 to 8.

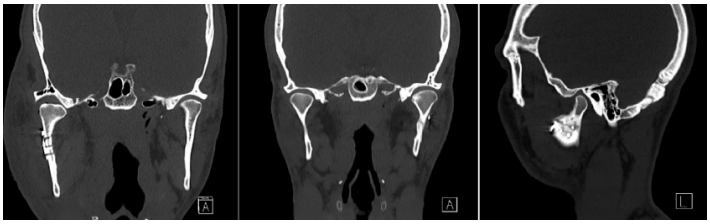


Figure 2. CT scan samples for ORIF operation. Left: Early postoperative scan, middle and right: Late postoperative coronal and sagittal scans of another patient

Preoperative condylar heights had ranged between 13.7 and 33.8 millimeters (mean:19.37±5.75) whereas early postoperative condylar heights ranged between 9.7 and 32.2 (mean: 19.99±6.31) and late postoperative condylar heights ranged between 12.8 and 29.1 (mean:20.23±4.97). Preoperatively, changes in the condyle heights had ranged from a 31% height loss to an 18% height increase when compared to the healthy sides.

Preoperative condyle +ramus heights ranged between 48.5 and 74.6 millimeters (mean:65.06±6.75). Early postoperative condyle +ramus heights increased to a range between 55.3 and 78.7 (mean: 19.99±6.31) and late postoperative condyle +ramus heights decreased when compared to early postoperative results to a range between 51.1 and 77.5 (mean:66.82±6.8). Preoperatively, changes in the ramus + condyle heights ranged from a 13% height loss to a 2% height increase when compared to the healthy sides.

When the relationship of the mandible with the cranial base was checked, the distance between the Gonion and FH plane ranged between 58.1 and 80.2 (mean:71.19±6.1) preoperatively and ranged between 58.8 and 81.5 (mean:71.48±6.6) postoperatively. Late results did not show a large difference with a mean value of 71.5±7.02 (ranging between 54.4 and 82.3). Preoperatively, distance between the Gonion and FH plane changed from an 11% decrease to a 1% increase when compared to the preoperative healthy sides

The contralateral healthy sides were shown to be changed in the late postoperative period when compared to their preoperative values: condylar heights changed between a 33% height decrease and a 15% height increase and condyle + ramus heights changed between a 5% height decrease and a 15% height increase. Furthermore, the distance between healthy Gonion points and cranial base changed between a 14% decrease and a 15% increase in the late term when compared their states in the preoperative periods.

### Statistical Results

Statistical results related to the CT scans were outlined in tables 9 and 10. On the fracture side, late postoperative mean and median condyle heights, condyle + ramus heights and Go-FH plane distances were increased when compared to their preoperative counterparts, however, these increases were without significance (p=0.741). On the late postoperative period, mean and median condylar heights of the fractured and non-fractured sides were similar to each other with a p value of 0.684. Again, in the late postoperative period, mean and median condyle + ramus heights and Go-FH plane distances of the fractured sides were shorter when compared to the contralateral (healthy) sides, however these decreases also did not show statistical significance (p values=0.089 and 0.165).

**Table 1.** Demographic properties of the included patients and clinical results

| Patient Number | Year of Operation | Age | Accepted the late CT Scan | Follow Up Time | Gender | Age Group | Treatment | Occlusion | Interincisal Distance (in cm) | Mandibular Deviation | Questionnaire |
|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | 2021 | 11 | Yes | 7 Months | Male | Pediatric | ORIF+IMF | Normal occlusion | 3.2 | 1cm left | 59 |
| #2 | 2021 | 26 | Yes | 7 Months | Male | Adult | ORIF | Normal occlusion | 3.6 | 0.5cm right | 34 |
| #3 | 2021 | 19 | No | 8 Months | Male | Adult | Arch Bar | Normal occlusion | 5.8 | midline | 54 |
| #4 | 2021 | 23 | Yes | 6 Months | Male | Adult | ORIF+IMF | Normal occlusion | 4.1 | 0.5cm left | 54 |
| #5 | 2021 | 21 | Yes | 6 Months | Male | Adult | Arch Bar | Normal occlusion | 4.8 | 0.2cm left | 50 |
| #6 | 2021 | 20 | Yes | 6 Months | Male | Adult | ORIF+IMF | Normal occlusion | 5.2 | midline | 43 |
| #7 | 2020 | 29 | Yes | 6 Months | Male | Adult | ORIF | Lingual crossbite | 4.7 | 0.5cm right | 47 |
| #8 | 2021 | 40 | Yes | 14 Months | Male | Adult | Arch Bar | Normal occlusion | 3.7 | 0.3cm left | 47 |
| #9 | 2021 | 35 | No | 16 Months | Male | Adult | Arch Bar | Normal occlusion | 4.2 | 0.1cm right | 53 |
| #10 | 2016 | 70 | No | 63 Months | Male | Adult | Arch Bar | Normal occlusion | 4.5 | 0.2cm right | 45 |
| #11 | 2017 | 46 | No | 58 Months | Male | Adult | Arch Bar | Normal occlusion | 4.9 | midline | 52 |
| #12 | 2016 | 38 | Yes | 63 Months | Male | Adult | Arch Bar | Normal occlusion | 4.3 | 0.3cm left | 54 |
| #13 | 2017 | 9 | Yes | 74 Months | Female | Pediatric | Arch Bar | Normal occlusion | 3.8 | 0.2cm right | 48 |
| #14 | 2016 | 11 | Yes | 62 Months | Female | Pediatric | Arch Bar | Buccal crossbite | 3.6 | midline | 51 |
| #15 | 2017 | 24 | No | 50 Months | Male | Adult | Arch Bar | Normal occlusion | 4.1 | 0.1cm right | 49 |

**Table 2.** The table including adaptation of General Oral Health Assessment Index (GOHAI) Defined by Atchison et al. [18,19]

| Number | Question | Point | | | | |
|---|---|---|---|---|---|---|
| | | Never | Rarely | Sometimes | Usually | Always |
| 1 | Limit kinds or amounts of food you eat because of problems with your teeth or jaw | 5 | 4 | 3 | 2 | 1 |
| 2 | Have trouble biting or chewing any kinds of food, such as firm meat or apples | 5 | 4 | 3 | 2 | 1 |
| 3 | Able to swallow comfortably | 1 | 2 | 3 | 4 | 5 |
| 4 | Teeth or wires prevented you from speaking the way you wanted to | 5 | 4 | 3 | 2 | 1 |
| 5 | Able to eat anything without feeling discomfort | 1 | 2 | 3 | 4 | 5 |
| 6 | Limit your contacts with people because of the condition of your teeth or jaws | 5 | 4 | 3 | 2 | 1 |
| 7 | Displeased or unhappy with the looks of your teeth and gums, or jaws | 5 | 4 | 3 | 2 | 1 |
| 8 | Use medication to relieve pain or discomfort around mouth | 5 | 4 | 3 | 2 | 1 |
| 9 | Worried or concerned about the problems with your teeth, gums or jaws | 5 | 4 | 3 | 2 | 1 |
| 10 | Feel nervous or self-conscious because of problems with your teeth, gums or jaws | 5 | 4 | 3 | 2 | 1 |
| 11 | Feel uncomfortable eating in front of people because of problems with teeth | 5 | 4 | 3 | 2 | 1 |
| 12 | Teeth or gums sensitive to hot, cold or sweets | 5 | 4 | 3 | 2 | 1 |

**Table 3.** Preoperative CT scan measurements

| | | PREOPERATIVE MEASUREMENTS | | | | | |
|---|---|---|---|---|---|---|---|
| | | Affected side | | | Healthy Side | | |
| Patient Number | | Condyle Height | Condyle + Ramus Height | Go - FH distance | Condyle Height | Condyle + Ramus Height | Go - FH distance |
| #1 | ORIF+IMF | 17.9 | 48.5 | 58.1 | 20.8 | 54.5 | 62.6 |
| #2 | ORIF | 16.8 | 68.3 | 75.3 | 18.4 | 75.2 | 80.8 |
| #4 | Arch Bar | 15.8 | 64.8 | 71 | 22.6 | 74.7 | 80.1 |
| #5 | ORIF+IMF | 20.9 | 65.1 | 67.8 | 19.8 | 68.6 | 72.3 |
| #6 | Arch Bar | 18.7 | 74.6 | 80.2 | 19.4 | 76.7 | 81.1 |
| #7 | ORIF+IMF | 14.3 | 63 | 67 | 17.8 | 68.7 | 72.3 |
| #8 | ORIF | 13.7 | 69.1 | 76.9 | 19.8 | 73.4 | 75.9 |
| #12 | Arch Bar | 33.8 | 67.5 | 72.4 | 28.6 | 69.5 | 74.8 |
| #13 | Arch Bar | 22.1 | 66.9 | 70.6 | 20.3 | 65.6 | 69.6 |
| #14 | Arch Bar | 19.7 | 62.8 | 72.6 | 17.8 | 67.4 | 73.3 |

**Table 4.** Early postoperative CT scan measurements

| | | EARLY POSTOPERATIVE MEASUREMENTS | | | | | |
|---|---|---|---|---|---|---|---|
| | | Affected side | | | Healthy Side | | |
| Patient Number | | Condyle Height | Condyle + Ramus Height | Go - FH distance | Condyle Height | Condyle + Ramus Height | Go - FH distance |
| #1 | ORIF+IMF | 18.8 | 55.3 | 58.8 | 20.9 | 55.5 | 61.5 |
| #2 | ORIF | 23.3 | 71.3 | 74.8 | 21.9 | 71.4 | 74.2 |
| #4 | Arch Bar | 9.7 | 63.9 | 68.2 | 21.2 | 76 | 77.8 |
| #5 | ORIF+IMF | 21 | 69.2 | 70.5 | 18.1 | 65.8 | 68.2 |
| #6 | Arch Bar | 22.5 | 78.7 | 81.5 | 25.1 | 76.2 | 79.1 |
| #7 | ORIF+IMF | 12.9 | 65 | 69.1 | 17.4 | 68.2 | 71.4 |
| #8 | ORIF | 17.8 | 74.2 | 81 | 16.3 | 74.4 | 77.5 |
| #12 | Arch Bar | 32.2 | 63.9 | 72.7 | 29.8 | 70.3 | 73.8 |
| #13 | Arch Bar | 24.6 | 67.1 | 70.1 | 20.8 | 77.2 | 84.5 |
| #14 | Arch Bar | 17.1 | 61.1 | 68.1 | 17.6 | 65.4 | 68.8 |

**Table 5.** Late postoperative CT scan measurements

| | | LATE POSTOPERATIVE MEASUREMENTS | | | | | |
|---|---|---|---|---|---|---|---|
| | | Affected side | | | Healthy Side | | |
| Patient Number | | Condyle Height | Condyle + Ramus Height | Go - FH distance | Condyle Height | Condyle + Ramus Height | Go - FH distance |
| #1 | ORIF+IMF | 18.4 | 51.1 | 54.4 | 15.6 | 52 | 55.1 |
| #2 | ORIF | 22.1 | 70 | 74.4 | 21.4 | 72 | 74.4 |
| #4 | Arch Bar | 18.9 | 67.4 | 72.5 | 19.7 | 75.9 | 79.9 |
| #5 | ORIF+IMF | 21.5 | 68.2 | 70.7 | 21.1 | 70.2 | 72.4 |
| #6 | Arch Bar | 25.9 | 77.5 | 82.3 | 22.8 | 75.8 | 81.1 |
| #7 | ORIF+IMF | 13.5 | 66.2 | 66.8 | 15 | 67.3 | 70.9 |
| #8 | ORIF | 12.8 | 64.8 | 72.2 | 21.9 | 72.4 | 76.9 |
| #12 | Arch Bar | 29.1 | 63 | 73.2 | 26.4 | 67.8 | 73.8 |
| #13 | Arch Bar | 20.8 | 68.7 | 72.1 | 19.9 | 75.9 | 82 |
| #14 | Arch Bar | 19.3 | 71.3 | 76.4 | 21 | 79.1 | 81.9 |

**Table 6.** Table showing the amount of percentage loses. Numbers indicates how many percent of height/distance did the fracture side lose when compared to the non-fracture side. Positive values show percentage lose, negative values show percentage gain. Left group: comparison of preoperative values, Middle group: early postoperative comparison and Right group: comparison at the late term

| | | AMOUNT OF PERCENTAGE LOSE (COMPARISON BETWEEN THE BOTH SIDES) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Preoperative | | | Early Postoperative | | | Late Postoperative | | |
| Patient Number | | Condyle Height | Condyle + Ramus Height | o - FH distance | Condyle Height | Condyle + Ramus Height | Go - FH distance | Condyle Height | Condyle + Ramus Height | Go - FH distance |
| #1 | ORIF+IMF | 14 | 11 | 7 | 10 | 0.3 | 4 | -18 | 2 | 1 |
| #2 | ORIF | 9 | 9 | 7 | -6 | 0.1 | -0.8 | -3 | 3 | 0 |
| #4 | Arch Bar | 30 | 13 | 11 | 5 | 16 | 12 | 4 | 11 | 9 |
| #5 | ORIF+IMF | -5 | 5 | 6 | -16 | -5 | -3 | -1 | 3 | 2 |
| #6 | Arch Bar | 4 | 3 | 1 | 10 | -3 | -3 | -14 | -2 | -1 |
| #7 | ORIF+IMF | 20 | 8 | 7 | 26 | 5 | 3 | 10 | 2 | 6 |
| #8 | ORIF | 31 | 6 | -1 | -9 | 0.2 | -4 | 41 | 10 | 6 |
| #12 | Arch Bar | -18 | 3 | 3 | -8 | 9 | 1 | -10 | 7 | 1 |
| #13 | Arch Bar | -9 | -2 | -1 | -18 | 13 | 17 | -4 | 9 | 12 |
| #14 | Arch Bar | -11 | 7 | 1 | 3 | 7 | 1 | 8 | 10 | 7 |

**Table 7.** Table showing the amount of percentage increases of postoperative measurements on the fracture sides when compared to preoperative measurements. Positive values show percentage gain, negative values show percentage lose. Left group: comparison between the preoperative fracture side and early postoperative fracture side. Right Group: comparison between the preoperative fracture side and late postoperative fracture side

| | | AMOUNT OF PERCENTAGE LOSE (COMPARISON BETWEEN THE BOTH SIDES) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Between preoperative and early postoperative | | | Between preoperative and late postoperative | | |
| Patient Number | | Condyle Height | Condyle + Ramus Height | Go - FH distance | Condyle Height | Condyle + Ramus Height | Go - FH distance |
| #1 | ORIF+IMF | -5 | -14 | -1 | -3 | -5 | 6 |
| #2 | ORIF | -39 | -4 | 7 | -32 | -2 | 1 |
| #4 | Arch Bar | 39 | 1 | 4 | -20 | -4 | -2 |
| #5 | ORIF+IMF | -0.4 | -6 | -4 | -3 | -4 | -4 |
| #6 | Arch Bar | -20 | -5 | -2 | -39 | -4 | -3 |
| #7 | ORIF+IMF | 10 | -3 | -3 | 6 | -5 | 0.3 |
| #8 | ORIF | -30 | -7 | -5 | 7 | 6 | 6 |
| #12 | Arch Bar | 4.7 | 5 | -0.4 | 14 | 7 | -1 |
| #13 | Arch Bar | -11 | -0.3 | 0.7 | 6 | -3 | -2 |
| #14 | Arch Bar | 13 | 2.7 | 6 | 2 | -14 | -5 |

**Table 8.** Table showing the amount of percentage changes in the healthy sides between the late postoperative and preoperative results. Positive values show percentage gain, negative values show percentage lose

| | | AMOUNT OF PERCENTAGE LOSE (COMPARISON BETWEEN THE BOTH SIDES) | | |
|---|---|---|---|---|
| | | Between preoperative and early postoperative | | |
| **Patient Number** | | **Condyle Height** | **Condyle + Ramus Height** | **Go - FH distance** |
| #1 | ORIF+IMF | -33 | -5 | -14 |
| #2 | ORIF | 14 | -4 | -9 |
| #4 | Arch Bar | -15 | 2 | -0.2 |
| #5 | ORIF+IMF | 6 | 2 | 0.1 |
| #6 | Arch Bar | 15 | -1 | 0 |
| #7 | ORIF+IMF | -19 | -2 | -2 |
| #8 | ORIF | 10 | -1 | 1 |
| #12 | Arch Bar | -8 | -3 | -1 |
| #13 | Arch Bar | -2 | 14 | 15 |
| #14 | Arch Bar | 15 | 15 | 11 |

**Table 9.** Comparison of each side with their preoperative and postoperative counterparts

| | | Name | Mean | Median | Minimum | Maximum | Interquartile Range | Test |
|---|---|---|---|---|---|---|---|---|
| Comparison of the fracture sides | Condyle Heights | Preoperative | 19.040 | 17.350 | 13.70 | 33.80 | 5.78 | Friedman's Two Way Analysis of Variance by Ranks |
| | | Early post-operative | 19.070 | 19.90 | 9.70 | 32.20 | 9.75 | |
| | | Late Post-operative | 20.23 | 20.050 | 12.800 | 29.100 | 5.88 | |
| | Condyle + Ramus Heights | Preoperative | 64.020 | 66.0 | 48.50 | 74.60 | 8.15 | Friedman's Two Way Analysis of Variance by Ranks |
| | | Early post-operative | 65.950 | 66.050 | 50.90 | 78.70 | 10.28 | |
| | | Late Post-operative | 66.820 | 67.800 | 51.10 | 77.50 | 5.98 | |
| | Go to FH distance | Preoperative | 69.980 | 70.800 | 58.10 | 80.20 | 10.33 | Friedman's Two Way Analysis of Variance by Ranks |
| | | Early post-operative | 70.350 | 70.300 | 56.80 | 81.50 | 10.50 | |
| | | Late Post-operative | 71.50 | 72.350 | 54.40 | 82.30 | 5.18 | |
| Comparison of the healthy sides | Condyle Heights | Preoperative | 20.23 | 19.80 | 14.80 | 28.60 | 3.00 | Friedman's Two Way Analysis of Variance by Ranks |
| | | Late Post-operative | 20.48 | 21.05 | 15.00 | 26.40 | 3.45 | |
| | Condyle + Ramus Heights | Preoperative | 68.31 | 69.10 | 54.50 | 76.70 | 11.58 | Friedman's Two Way Analysis of Variance by Ranks |
| | | Late Post-operative | 70.84 | 72.20 | 52.00 | 79.10 | 8.23 | |
| | Go to FH distance | Preoperative | 73.06 | 73.55 | 61.10 | 81.10 | 12.43 | Friedman's Two Way Analysis of Variance by Ranks |
| | | Late Post-operative | 74.84 | 75.65 | 55.10 | 82.00 | 9.27 | |

**Table 10.** Comparison between the fracture and healthy sides

| | | | Median | Minimum | Maximum | Interquartile Range | Interquartile Range | Test |
|---|---|---|---|---|---|---|---|---|
| Condyle Heights | Preoperative | Fracture Side | 19.040 | 17.350 | 13.70 | 33.80 | 5.78 | Mann-Whitney U |
| | | Healthy Side | 20.230 | 19.800 | 14.80 | 28.60 | 3.00 | |
| | Early Postoperative | Fracture Side | 19.70 | 19.90 | 9.70 | 32.20 | 9.75 | Mann-Whitney U |
| | | Healthy Side | 20.61 | 20.85 | 14.60 | 29.80 | 5.58 | |
| | Late Postoperative | Fracture Side | 20.23 | 20.05 | 12.80 | 29.10 | 5.88 | Mann-Whitney U |
| | | Healthy Side | 20.48 | 21.05 | 15.00 | 26.40 | 3.45 | |
| Condyle+ Ramus Heights | Preoperative | Fracture Side | 64.020 | 66.00 | 48.50 | 74.60 | 8.15 | Mann-Whitney U |
| | | Healthy Side | 68.31 | 69.10 | 54.50 | 76.70 | 11.58 | |
| | Early Postoperative | Fracture Side | 65.95 | 66.05 | 50.90 | 78.70 | 10.28 | Mann-Whitney U |
| | | Healthy Side | 68.95 | 70.85 | 54.50 | 77.20 | 12.83 | |
| | Late Postoperative | Fracture Side | 66.82 | 67.80 | 51.10 | 77.50 | 5.98 | Mann-Whitney U |
| | | Healthy Side | 70.84 | 72.20 | 52.00 | 79.10 | 8.23 | |
| Go to FH distance | Preoperative | Fracture Side | 69.98 | 70.80 | 58.10 | 80.20 | 10.33 | Mann-Whitney U |
| | | Healthy Side | 73.06 | 73.55 | 61.10 | 81.10 | 12.43 | |
| | Early Postoperative | Fracture Side | 70.35 | 70.30 | 56.80 | 81.50 | 10.50 | Mann-Whitney U |
| | | Healthy Side | 72.53 | 74.00 | 57.30 | 84.50 | 11.60 | |
| | Late Postoperative | Fracture Side | 71.50 | 72.35 | 54.40 | 82.30 | 5.18 | Mann-Whitney U |
| | | Healthy Side | 74.84 | 75.65 | 55.10 | 82.00 | 9.27 | |

**Discussion**

The outcomes of the presented study revealed quite interesting results. First of all, the size of the study is not very large which can be accepted as a limitation. However, the number of the patients with one-sided sub-condylar fractures who do not have other displaced fractures is not that high. Gleaned from this, the sample can be accepted as sufficient. However larger studies would have more accurate results. In the presented study, the aim was to show the changes in long term results of the heights of fractured condyles, changes in the total heights of the mandibles on the fracture sides and changes in the spatial positions of the anguli with respect to the cranial bases.

In clinical practice, it's strongly believed that the ORIF technique is superior to the IMF/Arch-bar-only techniques (Figures 2 and 3), however late postoperative results were similar in both techniques. even though they were both listed as in the same group of treatment. In the late postoperative period, we see that the median condylar height on the fracture side increased by nearly 2.5 mm when compared to the preoperative median condylar height on the fracture side. However, in the long term, this gain did not prevent decrease of length of spatial position of the mandible as the median distance of the Gonion point to the cranial base on the fracture side was nearly 3 mm shorter when compared to the healthy side ($p=0.165$). In addition, in the long term, we saw with great interest that the healthy sides had measurement changes even if these changes did not show statistical significance. The possible theories underlying these changes include biases related to measurement differences and position changes, however these measurements had been performed twice to overcome this possible bias. Another possible theory for this is that the temporomandibular joint and mandible on the healthy side might adapt to the changing structure and show some changes in length with time. Regardless of whether the treatment options were ORIF or IMF/Arch-Bars-only, all the results of the study show that the condylar heights, total heights of the mandible on the fracture sides and spatial position of the anguli were not affected as was estimated in clinical practice. Clinical results of patients including occlusions, maximum mouth openings, and qualities of life were also quite satisfying.

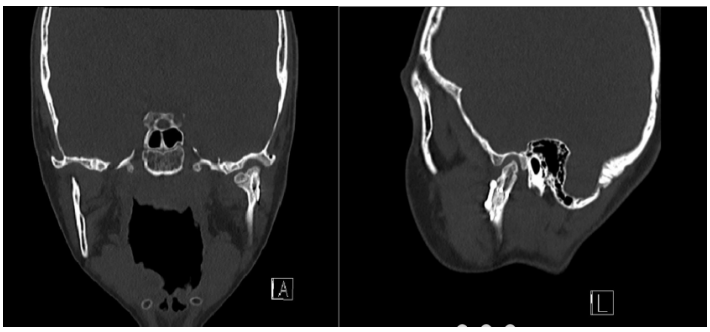



**Figure 3.** CT scan sample for a late term result of poor healing in the condyle after ORIF operation. Left: coronal view, Right: Sagittal view

The aims of repair surgeries for mandibular fractures include restoration of the pre-fracture occlusion, acceptable contact of the fractured segments, maintenance of the esthetic form, symmetry of the face [21] and the debate still continues for the best surgical approaches for mandible fractures after nearly a century [22]. In subcondylar fractures, treatment options include closed reduction and IMF, ORIF and ERIF. In a study conducted by Hackenberg et al. [23], a flowchart had been given for decision making in mandibular fractures: IMF should be selected in non-displaced or minimally displaced fractures where there is a functional occlusion and the function is normal. However, ERIF should be chosen when there is shortening of the ramus height even if the occlusion is normal and fractured segment is displaced minimally. What's more, ERIF can be selected when there is impairment of occlusion and the fractured segment exhibits lateral displacement or minimal medial displacement. In cases where there is occlusal impairment and difficulty of reduction or high level of displacement, ORIF should be chosen.

In former clinical practices with patients who had no restriction in mouth opening functions, mandibular subcondylar fractures were treated with IMF alone when there was bone-to-bone contact even though the patients had shortening of the ramus or medial displaced condyles. The final long term result was a normal occlusion and a functioning mandible with lateral deviation near maximum mouth opening (Figures 4 and 5). Gathered from this, the IMF after closed reduction was a commonly performed option and maintaining it for 3-6 weeks was accepted as quite a good option in many centers when there was no significant restriction in the temporomandibular joint movements and when there was no significant shortening in the ramus height. However, there are some debates about the inefficiency of closed treatment options and that choosing closed systems in the past had been based upon biases and closed options were performed to avoid the risks and technical difficulties of open techniques [24]. In the same study, superiority of the ORIF was expressed that a prospective study, which was conducted by Eckelt et al. [25], was halted earlier than expected based on the obvious superiority of the ORIF over closed options.

ERIF and ORIF are accepted to be the superior treatment options over the IMF-alone technique. Yet, they are not totally innocent considering higher possible complication rates. ERIF needs trained surgical teams who are capable of using endoscopic systems in mandibular fractures. When the leading player is ORIF, the things become more complicated. First of all, ORIF needs a skin incision leaving a scar that persists for decades even if it is concealed very well. Another problematic issue includes the existence of very important anatomic structures in very close proximity. In pretragal and retromandibular incisions, the surgeon would need to dissect through the parotid gland. The pure peripheral motor branches of the facial nerve traverse through the gland and can easily be severed or receive traction injuries during the operation. With retromandibular incision and transparotid dissection, reversible affection of the branches of the facial nerve can be as high as 48% [26]. Major risk factors for facial nerve damage were reported as existence of fracture dislocations, condylar neck fractures and low operator experience [27]. Dissections were deepened between the buccal and the zygomatic branches in the retromandibular incisions, whereas deepened above the zygomatic branch or posterior to frontal branch in pretragal incisions. These dangerous maneuvers which travel in close proximity to the facial nerve branches can easily cause transections, cautery burns or traction injuries. Another close anatomic structure is maxillary artery which passes just behind the condyle neck and possible incidental lacerations of the maxillary artery cause devastating bleeding

which is very difficult to control [28,29]. Another possible problem is salivary fistula which is caused by intraglandular dissection [30]. Restoration of the parotid capsule is an important key factor to prevent this complication [31].

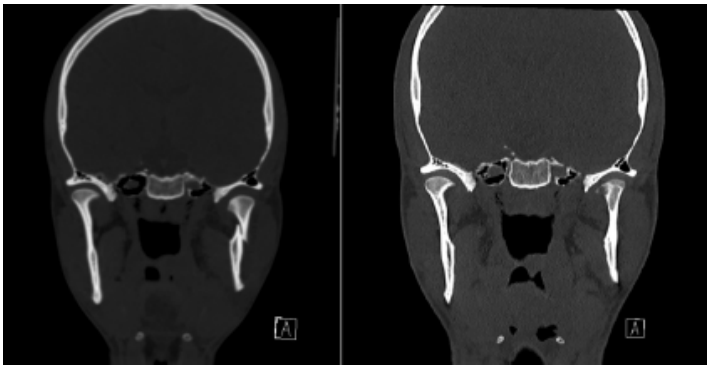
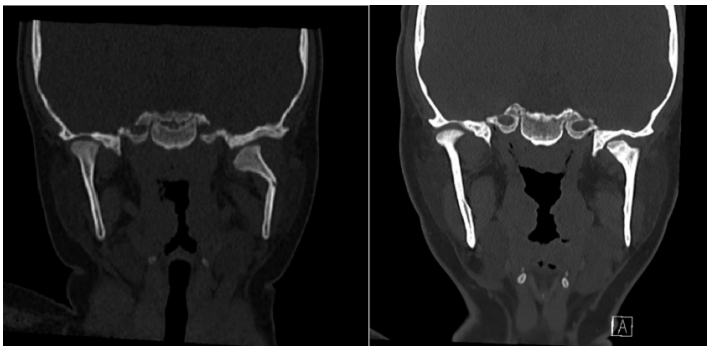


**Figure 4.** CT scan samples for excellent healing of a patients who had Arch Bars without ORIF



**Figures 5.** CT scan samples for excellent healing of a patients who had Arch Bars without ORIF

The long term results of IMF treatment including the effects on the rami heights, occlusal statuses and mandibular deviations with mouth openings is not effectively known. In our institution, we used to choose closed reduction and IMF over ORIF in past practices. However, ORIF has become the gold standard option in our clinic for the past 2 years. In our clinic, all patients with mandibular fractures get CT scans preoperatively and just after the operation. Attained from this, we now have the opportunity to measure preoperative and postoperative heights of the rami, reveal the long term success rates of the IMF technique and compare it with ORIF.

## Conclusion

In conclusion, satisfying clinical and radiologic results can be achieved with ORIF or IMF-alone techniques in sub-condylar mandible fractures. The data collected from this study showed that long term clinical results of both approaches are quite acceptable and the level of quality of life is high. Ascertained from this data, it should be aimed to reach a normal occlusion and a normal mouth opening capacity in the long term. IMF alone is not a poor option and can be used in selected patients. Important results that are related to late term prognosis of the subcondylar region fractures were achieved at the end of this study, however, further and prospective studies including larger patient numbers are needed to reveal the actual prognosis.

**Conflict of interests**
*The authors declare that there is no conflict of interest in the study.*

**Financial Disclosure**
*All authors declare no financial support.*

**Ethical approval**
*Ethical committee approval was obtained before the study (Prof Cemil Tascioglu City Hospital Clinical Ethical Committee 21.03.2022-136).*

## References

1. Rosignoli M, Paludetti G, D'Alatri L, Maurizi M. Our experience with mandibular fractures. Ann Ital Chir. 1990;61:255-63.
2. Hamill JP, Owsley JQ, Kauffman RR, Blackfield HM. The treatment of fractures of the mandible. Calif Med. 1964;101:184-87.
3. McInnes JD. Bone plating for fractures of the mandible. Can Med Assoc J. 1947;56:314.
4. Dingman RO. The management of Facial Injuries and Fractures of the Facial Bones. In: Converse JM, editor. Reconstructive Plastic Surgery. Vol 2. First ed. Philadelphia and London: W. B. Saunders; 1964;397-547.
5. Gilmer TL. A case of fracture of the lower jaw with remarks on treatment. Arch Dent. 1887;4:388.
6. Manson PN. Facial Fractures. In: Mathes SJ, Hentz VR, editors. Plastic Surgery. Vol 3: Head and Neck Part 2: Saunders. 2005;77-380.
7. Manson PN, Clark N, Robertson B, et al. Subunit principles in midface fractures: the importance of sagittal buttresses, soft-tissue reductions, and sequencing treatment of segmental fractures. Plast Reconstr Surg. 1999;103:1287-306;quiz 1307.
8. Strelzow VV, Friedman WH. Dynamic compression plating in the treatment of mandibular fractures. Early experience. Arch Otolaryngol. 1982;108:583-6.
9. Paresi RJ, Martin WJ, Figueroa AA, Polley JW. Fractures of the Mandible. In: Weinzweig J, editor. Plastic Surgery Secrets. 2nd ed. China: Mosby Elsevier; 2010;320-25.
10. Hammoudeh JA, Nathan N, Thaller S. Mandible Fractures. In: Kryger ZB, Sisco M, editors. Practical Plastic Surgery. Austin, Tx: Landes Bioscience Vademecum; 2007;248-57.
11. Adhikari M, Bhatt K, Yadav R, et al. Fixation of subcondylar fractures of the mandible: a randomized clinical trial comparing one trapezoidal plate with two miniplates. Int J Oral Maxillofac Surg. 2021;50:756-62.
12. De Riu G, Gamba U, Anghinoni M, Sesenna E. A comparison of open and closed treatment of condylar fractures: a change in philosophy. Int J Oral Maxillofac Surg. 2001;30:384-9.
13. Ellis E, 3rd, Moos KF, el-Attar A. Ten years of mandibular fractures: an analysis of 2,137 cases. Oral Surg Oral Med Oral Pathol. 1985;59:120-9.
14. Howard P, Wolfe SA. Fractures of the mandible. Ann Plast Surg. 1986;17:391-407.
15. Colangeli W, Lo Faro C, Cordaro R, et al. Mini-retromandibular transparotid approach to subcondylar fractures of the mandible A single Center clinical experience. Ann Ital Chir. 2019;90:244-51.
16. Bayat M, Parvin M, Meybodi AA. Mandibular subcondylar fractures: a review on treatment strategies. Electron Physician. 2016;8:3144-9.
17. Qu GL, Xu J, Zhou Q. Evaluation of the spatial position and correlation of mandibular ramus in skeletal class III patients with mandibular asymmetry. J Craniofac Surg. 2019;30:e439-e42.
18. Atchison KA. The General Oral Health Assessment Index (The Geriatric Oral Health Assessment Index). Chapel Hill, NC: University of North Carolina Dental Ecology. 1997
19. Atchison KA, Shetty V, Belin TR, et al. Using patient self-report data to evaluate orofacial surgical outcomes. Community Dent Oral Epidemiol.

2006;34:93-102.

20. Omeje KU, Rana M, Adebola AR, et al. Quality of life in treatment of mandibular fractures using closed reduction and maxillomandibular fixation in comparison with open reduction and internal fixation--a randomized prospective study. J Craniomaxillofac Surg. 2014;42:1821-6.

21. Guerrissi JO. Fractures of mandible: is spontaneous healing possible? Why? When? J Craniofac Surg. 2001;12:157-66.

22. Sorel B. Open Versus Closed Reduction of Mandible Fractures. Oral Maxillofac Surg Clin North Am. 1998;10:541-65.

23. Hackenberg B, Lee C, Caterson EJ. Management of subcondylar mandible fractures in the adult patient. J Craniofac Surg. 2014;25:166-71.

24. Strohl AM, Kellman RM. Current Management of Subcondylar Fractures of the Mandible, Including Endoscopic Repair. Facial Plast Surg Clin North Am. 2017;25:577-80.

25. Eckelt U, Schneider M, Erasmus F, et al. Open versus closed treatment of fractures of the mandibular condylar process-a prospective randomized multi-centre study. J Craniomaxillofac Surg. 2006;34:306-14.

26. Bhutia O, Kumar L, Jose A, et al. Evaluation of facial nerve following open reduction and internal fixation of subcondylar fracture through retromandibular transparotid approach. Br J Oral Maxillofac Surg. 2014;52:236-40.

27. Shi D, Patil PM, Gupta R. Facial nerve injuries associated with the retromandibular transparotid approach for reduction and fixation of mandibular condyle fractures. J Craniomaxillofac Surg. 2015;43:402-7.

28. Dingman RO, Natvig P. Surgery of Facial Fractures. Philadelphia: WB Saunders; 1964

29. Yeo MS, Goh TL, Nallathamby V, et al. Maxillary artery injury associated with subcondylar mandible fractures: a novel treatment algorithm. Craniomaxillofac Trauma Reconstr. 2012;5:83-8.

30. Ellis E 3rd, McFadden D, Simon P, Throckmorton G. Surgical complications with open treatment of mandibular condylar process fractures. J Oral Maxillofac Surg. 2000;58:950-8.

31. Aslan C, Hosnuter M, Bas S, et al. Retromandibular transparotid approach to mandibular subcondylar and high ramus fractures: two-point fixation. Ulus Travma Acil Cerrahi Derg. 2016;22:40-5.