

## Radiological Shortening of the Ramus: A Reliable Guide for Diagnosis of Unilateral Mandibular Condylar Fracture

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### ABSTRACT

**Aim:** The aim of this study was to assess and compare the radiological shortening of the ramal height on an Orthopantomogram (OPG) x-ray and Lateral Cephalogram for the diagnosis of a unilateral condylar fracture.

**Study Design:** Comparative Study.

**Place and Duration of Study:** Department of Oral & Maxillofacial Surgery (OMFS), Liaquat University of Medical and Health Sciences, Jamshoro, Hyderabad over a period of 6 months.

**Methodology:** The study included 100 patients coming to the OMFS department, 50 of them with unilateral condylar fracture made up the patient group, and the other 50 for the extraction of lower wisdom tooth comprised the control group. Both groups were having the standardized OPGs along with lateral cephalograms with them, age ranging from 18 and above of either gender. The following linear mandibular measurements were obtained in mm such as body length, ramal height and ramal shortening using both of the radiographs, respectively. Mean values of left and right sides of the OPG and the lateral cephalogram were calculated for both the parameters that is ramus height and body length. Comparison of the said parameters was also done, subsequently. The collected data was analyzed with the software SPSS 21.0 and Microsoft Excel.

**Results:** A total of 100 patients had been assessed and compared on the basis of the radiological shortening of the ramal height on the OPG x-ray and Lateral Cephalogram. The obtained data showed that there was a decrease in the ramal height on OPG as well as Lateral Cephalogram of the fractured patients compared to the non-fractured side, but there was a decrease in the ramal height of patients in the control group as well without having any fracture.

**Conclusion:** The shortening of ramal height measured on an OPG and Lateral Cephalogram cannot be relied upon to diagnose a unilateral condylar fracture.

*Keywords: Unilateral condylar fracture, Ramal height shortening, Orthopantomogram and Lateral Cephalogram*

## ABBREVIATION

OMFS: *Oral and Maxillo Facial Surgery*

OPG: *Orthopentamogram*

## 1. INTRODUCTION

In recent studies, mandible has proved to be the most frequently fractured bone.<sup>[2]</sup> According to the literature, mandibular fractures are almost 25.3% - 65.1% of all maxillofacial fractures.<sup>[4]</sup> This bone is more prone to fracture due to its mobility, position, prominence and lack of bony support, although it is the largest and strongest of the facial bones.<sup>[3]</sup> Furthermore, the gender ratio varies between 2:1-4:1 i.e. the former being male and later being female and most of the patients are in their twenties.<sup>[5]</sup> Condyle fracture most commonly occurs in the mandible fracture. The condylar process is liable because of its attachment which is with low stiffness on the neck area while that with the ramus is with high stiffness.<sup>[1]</sup>

Unilateral condylar fractures are seen more in men than in the women. Condylar fractures are seen more on the left side compared to the right. Out of all the condylar fractures reported, 19 per cent of the condylar fractures are undisplaced, 12% deviated and 69% displaced. Fifty-six per cent of the displaced fractures have some sort of overlapping (77% medial and 23% lateral), 37% demonstrate antero-posterior overlapping and in 6% of the cases there is no contact at all. Nineteen percent of all the condylar fractures are dislocated.<sup>[46]</sup>

The mandibular condylar process is the bilateral proximal part of the mandible, consisting of the condylar head, the neck and the base which forms the temporomandibular joint. It is a bilateral joint with a cartilage disc present between the mandibular head of the condyle and the glenoid fossa of the temporal bone. The small bony structure is fragile and thus, it fractures relatively easily when a blunt trauma impacts on the mandibular body or ramus.<sup>[6]</sup>

The maxillofacial fractures varies widely between different places. Violence, domestic abuse and traffic accidents, followed by sport injuries and fall are the main causes for such fractures.<sup>[7]</sup>

Clinically, a mandibular condylar fracture will present with a specific malocclusion and a classic open bite, swelling, joint tenderness, limited mandibular movement, chin deviation, crepitus, and laceration.

Condylar fractures can be treated by two different techniques, named closed technique or surgically by open reduction and internal fixation. Clinical and radiological findings can help plan the management and treatment for the mandibular condylar fracture such as the exact extent of the unilateral or bilateral injury, degree of dislocation, fracture displacement and the exact level of the condylar fracture.<sup>[8]</sup>

Around 9 - 36% is the reported overall complication rate for all mandibular fractures. The complications described most frequently are asymmetry of the mandible, pain in the temporomandibular joint, malocclusion, and paresthesia of the facial nerve, infection, and hemarthrosis and ankylosis. Diagnostic imaging makes it easy to classify the fractures according to its severity which helps us decide different treatment options. Eventually the main idea is to avoid any malunion to happen or nonunion, and delayed union by achieving maximum occlusion.

With the help of these common projections a panoramic - Lateral projection view and the radiologic analysis made using Towne's views (oblique frontal projection) has helped diagnosing the condylar fractures with much ease and accuracy.<sup>[11]</sup> OPG provides a comprehensive view of a maxillofacial complex with relatively reduced radiation exposure. It is also responsible to detect a mandibular fracture with 92% sensitivity compared to that of a mandibular set series which has a sensitivity of 66% only.<sup>[12]</sup> Even though the OPG x-ray has an increased sensitivity, like that of oblique and PA views, limited details are provided on the medially displaced mandibular condyle.<sup>[13]</sup>

X-rays such as an OPG, reverse Towne's view and PA view can only be taken for such patients who can walk around and can move their necks and have isolated fractures. For traumatic patients, Computer tomography is the standard imaging technique.<sup>[14]</sup> Mandibular Condylar fractures were diagnosed and classified using OPG and Towne image until recently. Decrease in the mandibular ramal height and angulation of the condylar process could be evaluated, to assess displacement and possibly dislocation out of the glenoid fossa.<sup>[15]</sup>

In 1931, the arrival of Lateral cephalogram provided a clinical tool to assess the underlying skeletal disproportions, since then the surgeons have used it widely to diagnose and analyze dentofacial deformities, it gives us a glimpse of the condyle and the temporomandibular joint region and can be appreciated for any

displacement or fracture at the condylar level. However one of the drawbacks of this x ray is that it causes overlapping of both the sides and causes interference due to superimposition of certain structures creating problems in the measurements.<sup>[17]</sup>

The treatment of mandibular condyle fracture till date remains controversial. In general there are two treatment options. The conservative treatment which is intermaxillary fixation (IMF) with wires or screws along with certain dietary advice.<sup>[19]</sup> The IMF is either rigid or semi-rigid with guiding elastics, for a period between 1 to 6 weeks.

The other treatment options is surgical, where the bone fragment is repositioned anatomically and fixed with osteosynthesis material such as mini-plates, lag screws or wires. Most commonly conservative treatment suffices, unless the condyle shifts to the middle cranial fossa causing bleeding, or disturbed occlusion or there's an extra capsular displacement of the condyle or infection at the site of the condylar fracture.<sup>67</sup> However, both surgical and conservative treatment plans have their own set of complications.<sup>[21]</sup>

Studies have shown that when a patient has unbearable pain, the degree of the condylar fracture angle is around or greater than 11 degrees, the height reduction of the ramus of the mandible on the affected site is more than 4mm and the patient is seriously affected.

Mouth opening becomes a challenge when the condylar fracture causes extreme shortening of the ramal height and increased deviation of the condyle. Patient quality of life might be seriously compromised if the opening is less than 10mm. The condylar angle along with the mandibular ramal height have a significant impact on the prognosis.<sup>[68]</sup>

Although, previous studies have showed how measurements can be implemented for the management of condylar fracture but no such publication of quantitative measurement has shown to be valid or accurate regarding the decrease in ramal height.

Condylar Fracture can cause limited mouth opening, deviation, pain, difficulty in swallowing and limits the quality of life, hence it is very important to diagnose the fracture in order to plan proper treatment and avoid ankylosis. For that reason, diagnosing unilateral condylar fracture on an OPG and lateral cephalogram using the ramal height as a guide is a good predictor and cost effective method for the patients.

Purpose of this study is to evaluate the ramal height shortening in patients with unilateral condylar fracture, compare them with the difference of ramal height found in a control group and to clarify the possible application of OPG for evaluating the linear measurements of mandible in diagnosing the unilateral condylar fracture by comparing it with Lateral Cephalogram. The goal was to find out whether measurement of shortening of ramus is a good diagnostic tool for indicating a unilateral mandibular condylar fracture.

## 2. MATERIALS AND METHODS

All the patients who presented to the Liaquat University of medical health sciences (LUMHS) department of OMFS with a unilateral condylar fracture between December 2020 and April 2021 were put in Group A - (Patient). The convenient sampling technique was used to recruit patients for this comparative study. The inclusion criteria included: age over 18 years or above of both gender, and availability of a preoperative Orthopantomogram (OPG) and Lateral Cephalogram. The exclusion criteria included: other mandibular trauma, pathological fracture of the mandible and bilateral condylar fracture.

The Group B - (Control) had patients who came to the LUMHS department of OMFS for extraction of third molar in the months of October 2020 to March 2021. The inclusion criteria was that of the Group A, and exclusion criteria was: any other mandibular trauma or pathology. The sample size was taken from Epi Tools epidemiological [www.epitools.ausvet.com.au/](http://www.epitools.ausvet.com.au/) The sample size was 90<sup>7</sup>: to compensate the loss, 10% was added for non-respondents, hence sample size was 100 with 50 in each group.

### 2.1 Data Collection Procedure

Diagnosis of the fracture was done on the basis of clinical examination and radiographic evaluation using an OPG and lateral cephalogram taken from the radiology department of Advanced Dental Care Centre, Hyderabad (ADCC). Standardized exposure parameters were kept for every panoramic radiograph and lateral cephalogram and were taken by a single operator. Following parameters were kept into consideration: Adult – Medium, tube voltage kV = 72, tube current mA = 6.0, exposure time 13.8 s, 6.70uGym<sup>2</sup>.

All other relevant information was recorded on Performa. The digital panoramic and lateral cephalogram images were saved in a JPEG file format where mandibular ramus linear measurements were performed. The following

linear mandibular measurements were obtained in mm such as body length (the distance between the gonion and menton), ramal height (measured between the highest point of the condyle and the gonion) and ramal shortening (difference between the fractured and uninjured ramal height) from both the groups using both the radiographs, OPG and Lateral cephalogram. Mean values of left and right sides of the OPG and the lateral cephalogram were calculated for both the parameters that are ramus height and body length. Comparison of both the parameters which is ramus height and body length between Lateral cephalogram and OPG (right and left sides) were also done.

### **2.1.1 Data Analysis**

The collected data was analyzed with the software SPSS 21.0 and Microsoft excel for statistical analysis using discriminant methods. The frequency and percentage was computed for qualitative variables, like sex, Mean  $\pm$  standard deviation were computed for quantitative variables, like age. Linear measurements were assessed on OPG and lateral cephalogram by the single investigator. Mean and standard deviation were calculated for all the parameters from OPG and lateral cephalogram. Independent t-test were performed for comparison of fractured and non-fractured ramal heights on OPG and lateral cephalogram using SPSS 21.0 with a probability level of  $P < 0.05$  considered to be statistically significant.

## **3. RESULTS**

The patients group contained 92% males and 8% females. Whereas the controls comprised of 96% females and 4% males. The mean age of controls was 29.82 and that of patients was 34.8. The right and left side values of the OPG and lateral cephalogram were compared of the Control group. Mean values and standard deviation of left and right sides of the OPGs and Lateral cephalogram were calculated and tabulated for all the parameters. No statistically significant difference was found. Although there was a slight difference found in the ramal height of patients in the Control Group; those having no fracture.

No statistically significant difference was found in the means of the ramal height of the control group, although out of 50 patients in the Control group 10 of the patients had around 1 to 2mm of difference in the ramal height regardless of the fracture. (Table 2 and 3)

Similarly, Mean and standard deviations were

calculated for the ramus height, and mandibular body length measured from the lateral cephalogram and OPG. No statistically significant difference was found between OPG and lateral cephalogram for the ramal height but a statistically significant difference was found when the OPG measurement was compared with lateral cephalogram for body length. Around 3 to 4 mm of difference was seen in the ramal height in the Patients group when compared with non-fracture side on the OPG. Same results were observed on Lateral cephalogram as well. (Table 10)

Although there was a significant difference in the ramal height of patients with condylar fracture when compared it with the control group but the control group itself had a difference of ramal height when compared with each side of the patient. The overall result showed that there was no significant difference between the overall mean of the ramal height between the patient and control group.

## **4. DISCUSSION**

There's a huge debate going on regarding condylar fracture treatment. Some prefer conservative approach which avoids nerve damage, scar formation and postoperative pain. While others regard surgical approach as the best treatment for it's easy to reduce and fix the fracture for future restoration. Ongkosuwito et al conducted a study using a dry skull and came up with the conclusion that an OPG is as reliable as a lateral cephalogram for linear measurements of the mandible. Fatahi and Babouei evaluated the reliability of the cephalometric measurements when determined from an OPG.

Ramal height measurements on an OPG in patients with unilateral condylar fractures has been discussed earlier. Quantitative measurements for open reduction and internal fixation of such cases are regarded as if the reduction of ramal height is of 2mm or more and angular deviation is of 10 degrees or more.<sup>[69]</sup> Some of the studies described the surgical approach to these fractures. Sugiuria et al. discussed ramus shortening of 7mm or more or 35 degrees of angular deviation or more can be an indication for open reduction and internal fixation.<sup>[69]</sup> Though there might be some other work done on the ramal height regarding its shortening for the treatment of condylar fracture<sup>[69]</sup> very limited data is available.

**Table 1. Details of patients (n=100)**

Variables		Controls		Patients with Unilateral fractures	
Variables	OPG Left	OPG Right		P value	
Mean (range) Age (years)		29.82 (24 – 42)			34.8 ( 18 – 54)
Ramus Height	51.47 + <sub>-</sub> 4.94		51.51 + <sub>-</sub> 5.14		0.011
<b>Gender</b>					
Body Length	78.25 + <sub>-</sub> 6.38		74.87 + <sub>-</sub> 6.62		0.155
Male		2			46
Female		48			4

**Table 2. P value to the comparison of the Left and Right sides of the OPG of the Control Group**

Variables	OPG Left	OPG Right	P value
Ramus Height	50.77 + <sub>-</sub> 5.32	50.71 + <sub>-</sub> 5.33	0.477
Body Length	78.25 + <sub>-</sub> 6.38	78.10 + <sub>-</sub> 6.39	0.001

**Table 3. P value to the comparison of the Left and Right sides of the Lateral Cephalogram of the Control Group**

Variables	L.C Left	L.C Right	P value
Ramus Height	48.84 + <sub>-</sub> 5.51	48.77 + <sub>-</sub> 5.67	0.458
Body Length	62.24 + <sub>-</sub> 5.82	62.13 + <sub>-</sub> 5.84	0.450

**Table 4. P value to the comparison of the Left sides of the OPG and Lateral Cephalogram of the Patient Group**

Variables	OPG Left	L.C Left	P value
Ramus Height	50.77 + <sub>-</sub> 5.32	48.84 + <sub>-</sub> 5.51	0.011
Body Length	78.25 + <sub>-</sub> 6.38	62.24 + <sub>-</sub> 5.82	0.010

**Table 5. P value to the comparison of the Right sides of the OPG and Lateral Cephalogram**

*\*Significant difference was found in the body length*

Variables	OPG Right	L.C Right	P value
Ramus Height	50.71 + - 5.33	48.77 + - 5.67	0.052
Body Length	75.47 + - 5.83	62.13 + - 5.84	0.119

*when the readings were compared to that of OPG with Lateral Cephalogram*

**Table 6. P value to the comparison of Left and Right sides of the parameters on OPG of the Patient Group**

Variables	L.C Left	L.C Right	P value
Ramus Height	48.59 ± 5.38	48.44 ± 5.11	0.102
Body Length	63.22 ± 7.99	63.11 ± 8.11	0.265

**Table 7. P value to the comparison of Left and Right sides of the parameters on Lateral Cephalogram of the Patient Group**

Variables	OPG Left	L.C Left	P value
Ramus Height	51.47 ± 4.94	48.59 ± 5.38	0.011
Body Length	78.25 ± 6.38	63.22 ± 7.99	0.155

**Table 8. P value to the comparison of left sides of the Patient group**

Variables	OPG Right	L.C Right	P value
Ramus Height	50.71 ± 5.33	48.44 ± 5.11	0.052
Body Length	75.47 ± 5.83	63.11 ± 8.11	0.355

**Table 9. P value to the comparison of Right sides of the Patient Group**

Variables	Fractured side on L.C	Non-fractured side on L.C	P value
Ramus Height	49.92 + - 5.08	53.06 + - 4.46	0.446
Variables	Fractured side on OPG	Non-fractured side on OPG	P value
Ramus Height	51.47 + - 4.94	53.14 + - 4.36	0.496

**Table 10. Comparison of fractured side with Non-fractured side in Patient group**

\*Around 3 to 4 mm of difference was seen in the ramal height in the Patients group when compared. Same results were observed on Lateral Cephalogram

Parameters	Ramus Height	t value	P value
Left sided Fracture	49.92 +- 4.82	- 0.177	0.861
Left sided Control	50.77 + - 5.31	- 0.177	0.861
Right sided Fracture	53.45 + - 4.45	-1.43	0.165
Right Sided Control	50.71 + - 5.33	-1.43	0.165

**Table 11. Comparison of Ramus Height of Fracture side with Control Group**

Maximal Ramal Shortening	
Group A (Control Group)	2.78 mm
Group B (Patient Group)	8.93 mm

For condylar fractures which are moderately displaced, closed treatment with intermaxillary fixation with rigid elastics is still frequently used. This is because the difficulty index is high for treating such fractures surgically due to its access and because of its proximal fragment repositioning difficulty. When a patient presents with bilateral condylar fractures and severely displaced condyles ORIF is the best treatment option for them while that with not so severe condylar fracture can be treated closely.<sup>[70]</sup>

ORIF can be done by mini plate, intraosseous screws and fixation wires. Closed treatment can be done by an IMF for 2 to 3 weeks using Erich splints, Ivy, or mono cortical screws. Most clinicians prefer ORIF over closed treatment due to its better prognosis and healing of the joint along with its surrounding soft tissues, however risk of nerve damage is there which is not avoidable.

Closed treatment has its benefits of avoiding a surgical procedure and is treated conservatively by allowing the condyle and muscles of mastication to heal on its own through remodeling but it does have its own disadvantages as it might cause disturbed occlusion, facial asymmetry and pain.<sup>[71]</sup> Both treatment options have their own pros and cons, hence it should be planned accordingly.

Here some studies have been shown which has discussed the condylar treatment using the quantitative measurements such as the ramal height. The results were compared to open and closed treatments of a condylar fracture. The patients from the open group definitely had better results than that of closed but both had occlusion problems.<sup>[72]</sup>

The goal of this study was to calculate and measure the difference in ramal height in a unilateral condylar fracture and to see whether it was easy to diagnose a unilateral condylar fracture on an OPG and Lateral cephalogram on the basis of its ramal height shortening. Limitations of this study might have been due to small sample size, and unavailability of resources, and that part of the data which showed that a patient had shortness of ramal height regardless of the fracture.

The result of this study showed that the mean ramal height was less among the patients with unilateral condylar fracture than the controls but there was a difference in ramal height in control patients as well.

It can be concluded that in fracture patients the

height is overall decreased in comparison to the non-fractured side but the control group also showed difference in ramal height regardless of the fracture which makes it debatable to be used as a proper guide for diagnosis.

## 5. CONCLUSION

It can be concluded that although there is a significant decrease in the ramal height seen on OPG and Lateral Cephalogram of the patient with a unilateral condylar fracture compared to its non-fractured side, but there is also a decrease in the ramal height of people in the control group as well.

Hence just by measuring the shortening of the ramal height on an OPG and Lateral Cephalogram one cannot justify the unilateral condylar fracture of the patient, although the shortening of ramal height can further help in deciding the proper management of the fracture that is whether to treat it conservatively or opt for surgery. Further study is required to check at which point can we treat a patient surgically rather than doing conservative management.

## CONSENT

Written informed consent form was obtained from the patients in their medical file before filling up the Performa to use their data for any research purpose.

## ETHICAL APPROVAL

The ethical permission was sought from the Ethical Review Committee (ERC) of the Liaquat University of Medical and Health Sciences. In addition, departmental permission was also sought from Department of Oral and Maxillofacial Surgery.

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