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Efficacy of the Lambda A-Plate Versus Two Mini Plates in the Repair of Subcondylar Fractures

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Abstract

Purpose: To evaluate the effects of treating subcondylar fractures with a three-dimensional lambda-A plate against two microplates, both clinically and radiographically. **Patients and methods:** A total of 16 patients with subcondylar fractures who were recommended for stiff internal fixation and open reduction participated in the research. Two groups of eight patients each were randomly assigned to the patients: study group A received treatment on lambda-A plates, whereas control group B received treatment on two small plates. Cone beam computed tomography was performed on the patients both immediately after surgery and 3 months later, in addition to clinical follow-up for 3 months. **Results:** All statistical tests were two groups and performed at a significance level of ′5 = 0.05 and by using Student's *T*-test (Student's *t*-test: $t = 2.414$, $P < 0.05$). Except hardware cost and fixing time, there was a statistically insignificant difference between both groups in any of the comparisons since lambda-A plates were less expensive and required less time. **Conclusion:** As a lambda A plate demonstrated comparable clinical and radiographic outcomes to two miniplates while requiring less operative time; it is strongly recommended for the majority of subcondylar fracture types.

Keywords: Lambda A-plate, Mini plates, Subcondylar fractures

1. Introduction

In patients with dentulous or edentulous mandibles, condyle fracture makes up about 30 and 37 % of mandible fractures, respectively. The high prevalence of mandibular condyle fractures may be attributed to the contrasting stiffness properties between the mandibular ramus, which exhibits high stiffness, and the mandibular condyle head, which displays low stiffness [1].

Indirect force applied to the mandibular condyle head typically results in this. Physical trauma is the most frequent external causal cause; other external causative factors include automobile accidents, acts of violence, workplace hazards, falls, sporting events, and gunshot wounds. Internal causes of some medical conditions include osteomyelitis, benign or malignant tumors, and muscular spasms resulting from electric shock treatment. A suitable therapy is needed to recreate the form and functionality of the uninjured status since mandibular fracture may lead to problems that are difficult to recover from both an aesthetic and functional standpoint. The need for accurate diagnosis, appropriate reduction and stable fixation, and the avoidance of complications cannot be overstated in this context. The optimum course of treatment for these fractures is still debatable, especially when choosing between an open or closed fracture [2]. Given the anatomical proximity of the condylar neck and subcondylar region to the parotid gland and facial nerve, the management of fractures in these areas presents similar difficulties in terms of determining an optimal treatment approach. Based on the classifications proposed by Merli et al. [3] and Kocaaslan et al [2], it can be determined that a fracture line occurring inside the condylar head is categorized as ‘intracapsular,’ whereas a fracture line occurring within the condylar neck is classified as ‘extracapsular’ if it extends beyond the sigmoid

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notch. Subcondylar fractures are categorized by a fracture line extending under the sigmoid notch in the upper portion of the vertical ramus. The most common form of treatment for mandibular condyle fractures is closed reduction, which includes intermaxillary fixation and physical rehabilitation. However, a sizable portion of adult patients who underwent closed reduction have been shown to have functional discord and unsatisfactory outcomes [3–5]. The challenge of moving the fragments in a constrained space while running the risk of harming face nerves or blood arteries like the internal maxillary artery led to the adoption of a less aggressive surgical method. Occlusal stability, functional reduction, and prompt function restoration are the most important justifications for open reduction and internal fixation (ORIF). The choice to move forward with ORIF raises two additional, connected, and contentious challenges, namely:

(a) The right kind of fixation device.
(b) The surgical strategy chosen.

There are numerous fixation procedures available, including plating, external fixators, transosseus wire, pin fixation methods, and lag screw fixation. The most often used procedures for bone plating are preauricular, submandibular, and retromandibular approaches [6]. The greatest way to counteract stress and pressure forces and provide more stability is with two miniplates (double-plate approach) [7,8].

Their use might necessitate an extraoral surgical technique, which has drawbacks including the potential for facial nerve damage and obvious scarring. One potential option is the use of the intraoral approach with endoscopic control. Nevertheless, the limited area available may provide difficulties in the application of two small plates [9,10]. Specially designed plates, such as the delta plate or the trapezoid plate, provide a feasible alternative to the modified two-miniplate approach. Numerous biomechanical and clinical investigations have shown the efficacy of these plates in efficiently mitigating stresses to a sufficient degree. The use of smaller plates offers many benefits owing to their capacity to provide adequate stability during ORIF interventions targeting subcondylar and condylar neck fractures [11–13].

2. Patients and method

2.1. Patients

A study was conducted with a cohort of 16 patients who had subcondylar fractures and were considered appropriate candidates for open reduction and rigid internal fixation. The participants were assigned to two groups using a random allocation method., with each group consisting of eight patients. Study group A was subjected to treatment using a lambda-A plate, while control group B received treatment using osteosynthesis with two mini plates obtained from the Oral and Maxillofacial Surgery Department at the Faculty of Dental Medicine, Al-Azhar University for Girls and the Maxillofacial Surgery Department at Ahmed Maher Teaching Hospital. The selection of participants for both groups was based on predetermined inclusion criteria. The patients were clinically monitored and underwent cone beam computed tomograms immediately after the surgery, as well as during the 3-month follow-up period. The individuals in question did not possess any specific medical background. All patients were provided with written documentation on the surgical procedure and provided written consent after being adequately informed. In a sample of 16 persons who underwent open reduction and fixation for subcondylar fractures, it was noted that four patients were female, representing 25 % of the overall sample, while the other 12 patients were male, totaling 75 % of the sample.1 2 patients out of 16 were suffered also from other concomitant fractures such as parasymphysial or mandibular body fracture but not complete lefort fracture to avoid affecting on facial height and the final results. The age distribution of participants in the study cohort spanned from 22 to 44 years, with a mean age of 34.25 years and a SD of 8.59 years. In contrast, the control group had a mean age of 30.5 years, accompanied with a standard deviation of 6.63 years.

2.2. Clinical procedures

Clinical examinations were performed to all patients to assist condylar region, mouth opening, midline deviation, and occlusion. The patients were separated into two categories, each comprising eight individuals who had displaced subcondylar fractures that impacted mouth opening and occlusion. In group A, all patients received treatment using the lambda-A plate, whereas in group B, treatment included the use of two miniplates. A preoperative cone beam computed tomography (CT) scan was conducted to ascertain the location of the fracture line and the positioning of the condylar section.

2.3. Grouping of the patient

Displaced subcondylar fractures necessitating open reduction and stiff internal fixation were identified in 16 patients, eight of whom were randomly assigned to each of two groups.

2.4. Group A

In this group (study group A) the subcondylar fractures of the patients were treated using lambda-A plates.

2.5. Group B

In this group (control group B) the subcondylar fractures of the patients were treated using two miniplates, each one formed of four holes.

2.6. Surgical procedure

The modified retromandibular method was used to fix subcondylar fractures. A cut was made in the skin 0.5 cm below the lobule of the ear, 3–3.5 cm long, and not going past the angle of the jaw. Shallow dissection of the subcutaneous tissues was done, to focus on the superficial muscle aponeurotic system. The superficial musculoaponeurotic system and the parotid capsule were both cut so that they were in line with the skin. Once the masseter muscle fibers were visible, blunt dissection was done in an anterior to medial direction, going along the expected path of the facial nerve branches and finishing at the back edge of the mouth. Even though the marginal mandibular nerve fibers may not always be visible, it is still important to be careful and make sure they are kept safe while the lower layers are being cut open. After figuring out where the back edge of the jaw was, the pterygomasseteric sling was cut in place. It was possible to see the broken pieces because the masseter muscle and periosteum were cut from the angle of the mouth along its back edge.

The fracture was successfully reduced by direct visualization by retracting the ramus in a downward position, which provided access to the medial portion of the condylar segment. Maxillomandibular fixation was done and the fractured condylar segments were fixed by using lambda-A plates and 5–7 mm monocortical screws in all patients of group A (study group) as follow: The initial bridge of A plate exhibited parallelism with the posterior border of the mandibular ramus, which was considered the compression area. Conversely, the second arm of the bridge displayed parallelism with the sigmoid notch, known as the traction area. The superior region of the plate featured a group of three holes arranged in a triangular pattern, which were fixed to the proximal part. Additionally, three holes were linearly positioned on the inferior tails of the bridges, serving as fixation points for the distal part. Lastly, the other arm of the bridge was secured to both the proximal and distal segments (Fig. 1).

In group B, the fractured condylar segments were stabilized by the implementation of osteosynthesis utilizing two 2 mm microplates and 5–7 mm monocortical screws. The placement of these plates included positioning one plate parallel to the posterior edge of the ramus, while the second plate was positioned in close proximity to the sigmoid notch. Two screws were inserted into the proximal portion of each plate, while the remaining two screws were inserted into the distal segment. The maxillomandibular fixation was removed and the occlusion was assessed. The closure of soft tissue was performed in a sequential manner, with each layer being addressed individually. The subcutaneous tissues were meticulously sutured using vicryl 3–0, while the skin was carefully closed using prolene 5–0. In cases where a midline shift was present, the use of guiding heavy elastics were implemented for a duration of 1 week (Fig. 2).

3. Postoperative evaluation

3.1. Clinical evaluation

3.1.1. Extraoral evaluation

(i) The patients had clinical examinations at several time points after the operation, including the first day, first week, second week, first month, and third month. These examinations aimed to assess the integrity of the extraoral wound over the healing phase.
   (a) The lack of observable indicators of inflammation, such as erythema, increased temperature, and edema of the skin.

Fig. 1. Clinical photo showing fixation of left side of condylar fractured segments by A plate through modified retromandibular approach.

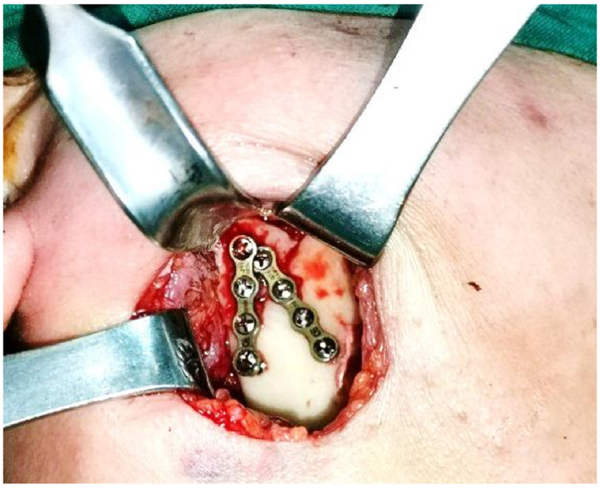

Fig. 2. Clinical photo showing fixation of right side condylar fractured segments by two miniplates through a modified retromandibular approach.

(b) The surgical plate did not exhibit any dehiscence or exposure.
(c) The lack of any infection, hematoma, or edema.
(d) The individual didn't have any neurological abnormalities.

Following a clinical assessment of the wound, the sutures located outside the mouth cavity were extracted 1 week after the surgical procedure.

3.1.2. Intraoral evaluation

(a) Maximum nonassisted mouth opening was measured at the immediate postoperative and after 2 weeks (inter incisal distance in mm).
(b) Deviation of mandibular midline was recorded at the immediate postoperative and after 2 weeks (deviated or not).
(c) Lateral and protrusive movements were recorded (in mm) at the immediate postoperative and after 2 weeks.
(d) Stability of the occlusion was recorded at the immediate postoperative and after 2 weeks (stable occlusion or malocclusion).
(e) The cost of lambda A-plate and the two miniplates were recorded in Egyptian pounds and also the time of surgery in minutes.

3.2. Radiographic evaluation

Computed tomograms were used to acquire three-dimensional (3D) reconstructed images in order to assess the appropriate reduction of the fractured segments and the condylar position immediately after the surgery (refer to Fig. 3) as well as 3 months after the surgery.

4. Results

The collected information was tabulated and subjected to further statistical analysis, which included both group-level and individual-level comparisons. All patients had a positive experience with the surgical procedure, and the results were considered clinically and radiographically adequate in terms of bone segment stability and occlusion. The difference between the two groups was not statistically significant.

4.1. Stability of bone reduction

There was a statistically insignificant difference seen in bone stability when comparing study periods within groups or between groups. Both groups had consistent results of 100 %.

4.2. Postoperative occlusion

Both immediately before surgery and at 2-month intervals afterward, the statistical analysis showed

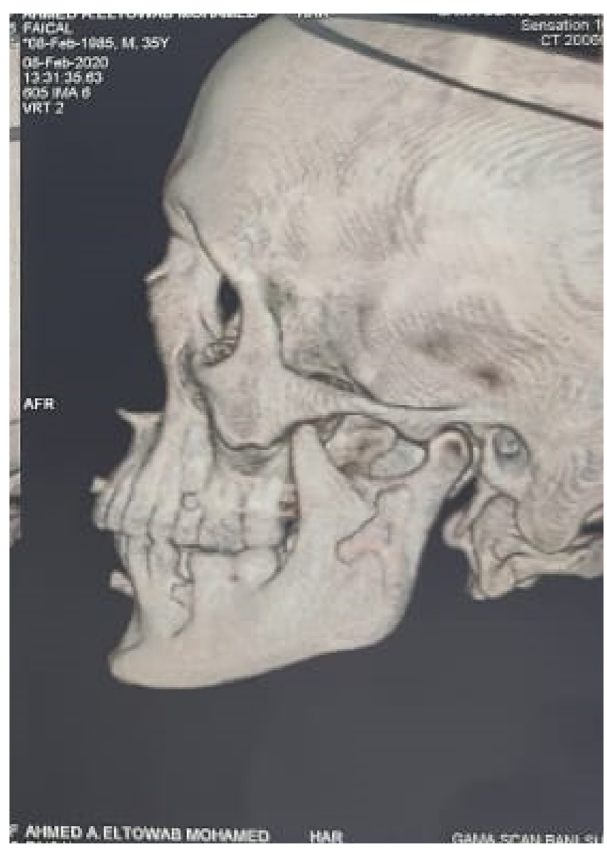

Fig. 3. Shows follow-up of fracture reduction and condylar position immediately postoperative by computed tomography.

no clinically meaningful difference in occlusal stability between the two groups.

4.3. Deviation of mandibular midline

Statistical analysis showed no significant difference in either intra-group or inter-group comparisons regarding mandibular midline shifting immediately postoperative and after 2 months, (100 %) of cases were with the normal mandibular midline.

4.4. Lateral and protrusive movements

There was a statistically significant change in lateral and protrusive movements between the immediate postoperative period and 2 months after surgery, as measured by intra-group comparisons within each group. No statistically significant differences in protrusive and lateral kinematics were seen between groups either immediately after surgery or two months later (Table 1).

4.5. Maximum mouth opening (inter incisal distance) millimeters

A statistically significant disparity was seen in the maximal mouth opening measurements when comparing the immediate postoperative period to the 2-month postoperative period within each group. There were statistically insignificant differences seen in maximal mouth opening between inter-group comparisons at both the immediate postoperative stage and the 2-month postoperative stage (Table 2).

4.6. Cost of plates and screws

Group A significantly outperformed group B statistically ($P \leq 0.001$).

Group B had the greatest mean value (800 0.00), while group A had the lowest (700 ± 0.00) (Table 3).

4.7. Time of reduction and fixation

Significantly different results were seen between group A and group B ($P \leq 0.001$).

The mean was greatest in group B (55.00 10.35), while the mean was lowest in group A (42.50 ± 9.25) (Table 4).

Associated complications.

(a) Two instances of marginal mandibular nerve affection were identified, one in the research group and one in the control group. One instance exhibited recovery after a duration of 2 months, while the other case showed recovery after a duration of 6 months.

(b) In a single incidence, lip paresthesia was seen before surgery in conjunction with a bodily fracture. The patient was thereafter monitored for a duration of 6 months, during which the

Table 3. The mean, standard deviation (SD) values of cost of plates and screws of all groups.

Variables	Cost of plates and screws	
	Mean	SD
Group A	700	0
Group B	800	0
P value	≤0.001*	

Table 1. The mean, standard deviation (SD) values of the lateral and protrusive movements of all groups.

Variables	Lateral and protrusive movements				*P* value
	Group A		Group B		
	Mean	SD	Mean	SD	
Immediately postoperative	5.62	1.06	5.37	1.30	0.680 ns
After 2 months	8.87	0.99	8.251	1.48	0.340 ns
P value	≤0.001*		≤0.001*		

P value less than or equal to 0.001*, *significant. Ns = Nonsignificant.

Table 2. The mean, standard deviation (SD) values of the maximum mouth opening (inter incisal distance) of all groups.

Variables	Maximum mouth opening (inter incisal distance) millimeters				*P* value
	Group A		Group B		
	Mean	SD	Mean	SD	
Immediately postoperative	26.62	5.75	24.87	5.46	0.543 ns
After 2 months	32.87	4.58	30.87	5.35	0.436 ns
P value	≤0.001*		≤0.001*		

P value less than or equal to 0.001*, *significant. Ns = nonsignificant.

Table 4. The mean, standard deviation (SD) values of time of reduction and fixation of all groups.

	Time of reduction and fixation	
Variables	Mean	SD
Group A	42.5	9.25
Group B	55	10.35
P value	≤0.001*	

affected nerve gradually restored its sensory function.

(c) In a single instance, the presence of parotid fistula was seen. To address this condition, a treatment plan was implemented, which included repeated aspirations and the application of compression dressings. Additionally, Hyoscine 10 mg tablets were administered twice daily for a duration of 10 days. The patient was also given antibiotics and analgesics.

5. Discussion

The majority of mandibular condylar fractures should be fixed rigidly after open reduction. The following should be made clear when considering surgical treatment: When treating condylar fractures, a variety of fixation methods and devices should be used [14]. The optimal surgical approach should prioritize minimal invasiveness, enabling a pleasant and straightforward resolution to the surgical concern. Additionally, it should demonstrate adaptability, facilitate satisfying visual outcomes, exhibit a low incidence of surgical complications, and possess a straightforward execution process. Closed reduction has traditionally been the preferred method for managing condylar fractures due to many factors. These include the potential for facial nerve problems associated with surgical intervention in the temporomandibular joint area, challenges in achieving anatomically precise reduction of the fractured fragments, and the development of a surgical scar. According to Tang *et al.* (2015), in ORIF surgeries, the modified retromandibular incision approach was employed for both condylar and mandibular ramal fractures. Injuries to the marginal branch of the nerve that runs through the face were more likely to occur during the retromandibular (transparotid) approach, as indicated by Trost *et al.* [15,16], which involves crossing this nerve. According to the findings of Chossegros *et al.* (2018), a total of 19 patients were evaluated, and it was noted that temporary palsies occurred in two individuals, representing 10 % of the sample. However, no definitive palsy was detected in any of the patients. Additionally, our investigation documented the occurrence of Marginal mandibular nerve involvement in two instances. One individual experienced recovery within a 2-month timeframe, whereas the other one achieved recovery within a 6-month timeframe.

During a high cervical transmasseteric anteroparotid approach, a super-facial dissection must be performed across the superficial musculoaponeurotic system at a precise distance of 45 mm above the inferior border of the jaw, making it necessary to avoid the marginal branch.

As a result, there have been quite a few successful results [17] with the use of conservative treatment. Successful anatomical repositioning, ramal length restoration, avoidance of long-term problems such as clicking and late arthritic changes, and expedited return to normal function are all made possible with the use of open reduction and strong fixation procedures [18]. The verification of accurate reduction of the fracture and placement of fixation devices may be readily assessed intraoperatively by the use of the mini-retromandibular technique, the maxillomandibular fixation can be withdrawn after the treatment [19]. The average operating time of 34 min illustrated how simple the access was. The mini-retromandibular method is a rather straightforward surgery. When performing ORIF via the retromandibular technique, the facial nerve, and its branches are put in danger; injury to these nerves could result in facial muscle paralysis.

In two patients, transient facial nerve paralysis was observed; it resolved 3 months after surgery. Manisali *et al.* [20], Ellis *et al.* [21], and Delvin *et al.* [22] similarly observed temporary facial nerve weakness in the postoperative period. In their investigation, Hyde *et al.* [23] reported the absence of facial nerve impairment in all patients. The occurrence of facial nerve weakness seen in our research may be related to a higher degree of soft tissue stretching. This can be explained by the relatively short length of the incision, which raised the likelihood of excessive stretching of the nerve fibers. Consequently, there was an increased incidence of temporary facial nerve weakness. The findings of Ellis *et al.* [21] and Delvin *et al.* [22] suggest that the retromandibular technique may provide advantages in terms of favorable cosmesis and sufficient surgical exposure. The surgical scar was invisible in all cases of our study. All patients in our study showed satisfactory centric occlusion. All patients' mouth opening grew over time, reaching a maximum of 44 mm at 3 months after surgery. This agreed with Hyde *et al.*'s findings [23]. Mouth opening was noticeably smaller after 1 week following surgery, which can be attributable to the soft tissue injuries sustained during surgery. The lateral movements of all patients in our study increased with time. Similar to Iannetti *et al.* [24], none of the patients experienced any restriction in their lateral movements. They attributed the restriction in lateral motions to the swelling and edema following surgery because the tissues were torn apart during surgery. At intervals of 24 h, 3 months following surgery, the approximate location of fracture fragments, plate fracture, and screw loosening on radiographs (Orthopantomography (OPG)) were assessed. According to Choi *et al.*'s research [25], the radiographs in every case showed that the fracture fragments were properly approximated and that the bone had healed well. Although there was no sign of plate exposure or screw loosening at the fracture location, this does not agree with the conclusions reached by Choi *et al.* [25].

Salivary fistula formation was recorded at 1 week postoperatively of one patient in this study which was treated conservatively. According to Kleinheiz and Meyer, the main cause for plate fracture was an inappropriate reduction [26,27]. As a result, reduction and fixation are connected. The lines of force distribution in the ramus dictate where the plates are placed. According to Meyer [27], compression is mostly along the posterior edge of the ramus while tension is maximum along the sigmoid notch. The upper portion of the condylar neck is where both line bundles converge. The optimal location for fixation of lower and intermediate high fracture would be right below the sigmoid notch due to the worse forces of stretching. Unfortunately, the bone there is thin, making it challenging to support the torsion brought on by lateral stresses. For this reason, the second plate should be placed at the ramus's posterior edge. It serves as the gold standard for condylar neck ORIF [28]. The lambda plate is helpful in all levels of neck fractures, but occasionally in high fractures; just two holes are insufficient to stabilize the reduced proximal fragment.

The lambda A condylar plate was designed and built using the aforementioned concepts (reinforcement, multipoint attachment, and 3D stability). Wider bars were placed along the physiological lines of compression and traction stresses that were used to achieve the reinforcement goal. There was no hole drilled into the bar, which has an expanded width of 2.5 mm. The condylar neck is supported in two places by twin bars that are both anterior and posterior. The method of achieving multipoint fixation involves the use of nine holes positioned at the top and two tails of the plate. This is accompanied by the implementation of 3D stabilization, which was facilitated by the use of an inferior connecting bar measuring 2.0 mm in width. The use of stiff internal fixation using many small plates has been shown to provide superior stability in all directions, except for the posterior to anterior direction, when compared with the trapezoid plate, delta plate, and dynamic compression plate [29].

The delta plate could withstand the maximum weights in this direction. The delta plate was second best in the other three directions, with data that were comparable to twin miniplates but smaller in magnitude [30]. By combining the benefits of the aforementioned plates, particularly the trapezoid and double miniplates, the proposed ACP offers 3D stability.

5.1. Conclusion

(a) 3D lambda A plate is an accepted device that could be used safely as an alternative to conventional two miniplates fixation for treatment of mandibular subcondylar fracture regarding clinical and radiological outcomes as bone stability, occlusion and, mandibular movements.
(b) 3D plates showed superior outcomes regarding time of fixation and cost of hardware.
(c) The third dimension Particularly in situations involving short proximal bone stumps and high subcondylar fractures, a plate demonstrated simpler implantation.

5.2. Recommendations

(1) The lambda A plate is recommended for the most types of subcondylar fracture.

Ethics information

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Biographical information

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Conflict of interest

There are no conflicts of interest.

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