



A Comparative Clinical Evaluation of Yang's Keyhole Plate Versus Conventional Plate For Treatment of Mandibular Sub-Condylar Fractures

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Codex : 11/2023/10

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KEYWORDS

Sub-condylar fractures,
Yang's Keyhole Plate, Miniplates.
Mandibular fractures , TMJ

ABSTRACT

Aim: To evaluate both clinically the use of keyhole plate compared with the two miniplates in fixation of extracapsular mandibular subcondylar fractures. **Subjects and Methods:** Twenty patients (16 males and 4 females) who met inclusion criteria were divided randomly into 2 equal groups. Group I: consisted of ten patients with extracapsular sub condylar fracture was treated with 2 yang's keyhole plates. Group II: consisted of ten patients with extracapsular subcondylar fracture were treated with two standard miniplates. Patients assessed clinically by Maximal mouth opening, Protrusive excursive movement, Lateral excursive movement, and Time for reduction and fixation. **Results:** maximum mouth opening, protrusive excursive movement, lateral excursive movement, At 1st week, 3rd week, 3rd month, and 6th month, there was a statistically non-significant difference between study and control groups. **Conclusion:** The YK-plate was thought to be easier to apply in clinical practice while taking advantage of sliding-plate system. Reduction of mandibular condylar fracture using YK-plate had shorter operative time compared to those with conventional mini plate rigid fixation.

INTRODUCTION

One of the most common mandibular bone fractures is subcondylar as it reaches up to 45% of all mandibular fractures however, management of mandibular condylar fractures remains an ongoing matter of controversy in maxillofacial surgery. This controversy is reflected in a wide variety of opinions and proposed treatment modalities offered in the literature. ⁽¹⁾

For decades, closed reduction had been the preferred treatment because it was easier, less invasive and results were comparable, with no surgical complications. However, closed reduction may comprise varying periods of intermaxillary fixation (IMF) (up to 6 weeks) followed by aggressive physiotherapy. ^(2,3) In addition, long-term complications such as pain, arthritis, malocclusion, deviation of mandible on opening

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and closing movements, temporomandibular joint (TMJ) dysfunction, facial asymmetry and reduced posterior facial height as well as ankylosis may occur in patients with condylar injuries treated in a closed manner.⁽⁴⁾

Authors preferred open reduction If there is a displacement of 10–45° or shortening of ramus by more than 2 mm. Open reduction–internal fixation (ORIF) allows anatomic repositioning and immediate functional movements of jaw, as well as reconstructing vertical ramus height.^(5,6) There has been an increasing interest in obtaining more immediate return to normal function by using different methods of direct fixation with an open approach and allowing anatomical reduction of fragments.^(7,8)

Today, open reduction and rigid internal fixation can be achieved with a variety of different plating systems using intraoral or extraoral approaches such as preauricular, retromandibular and endaural approach. However, condylar fractures are difficult to access through intraoral approach and need to be endoscope assisted.^(9,12)

Most plates currently on market are known to be associated with no difference in prognosis if bony segment is precisely anatomically reduced.^(13,14) In some patients, however, these miniplates are difficult to fit exactly to bone segment, and in subcondylar fracture sites, an extra-oral incision and an endoscope are needed for reduction and fixation of bone fragment. Therefore, surgery outcomes are sensitive and depend upon surgeon because miniplates are difficult to use in subcondylar area⁽¹⁵⁻¹⁷⁾. Unlike existing plates, the YK plate with different hole size that can enable simple fixation method.

Accordingly, the use of YK plate makes it possible to treat patients with subcondylar and angle fractures of mandible with a smaller incision length than required for existing plate system. Moreover, the first screw that is inserted can be used as an anchor screw, which can improve surgical convenience⁽¹⁸⁾.

SUBJECTS AND METHODS

Twenty patients (16 males and 4 females) were selected from outpatient clinic of Oral and Maxillofacial Surgery department, Faculty of Dental Medicine Al-Azhar University (Assiut Branch), suffering from extracapsular subcondylar fracture. Management was accomplished after case history, clinical and radiographic examination. All patients had signed an informed consent before surgery and study was ethically cleared by Al-Azhar ethical committee.

Inclusion criteria:

- Medically fit patients free from relevant conditions contraindicating surgery.
- Patients with age from 18-40 years old.
- Patients were suffering from displaced extracapsular mandibular sub-condylar fracture indicated for open reduction presented within two weeks form trauma.

All patients were sign a consent form before the study, (Attached).

Exclusion Criteria

- Infected fracture site.
- Patients with systemic bone diseases.
- Patient with normal occlusion.

Study sample:

Patients who met inclusion criteria were be divided randomly into 2 equal groups according to fixation technique using online software (<https://www.randomizer.org>)

Group I: consisted of ten patients with extracapsular sub condylar fracture was treated with 2 yang's keyhole plates. Group II: consisted of ten patients with extracapsular subcondylar fracture were treated with two standard miniplates.



Operative procedure

1. All patients were treated under general anesthesia with nasoendotracheal intubation.
2. After induction of anesthesia, the patient's areas of surgery scrubbed with povidone iodine surgical scrub solution, followed by oral cavity.
3. Draping of patient with sterile towels was done exposing only areas of surgery.
4. Intermaxillary fixation (IMF) was secured to provide proper occlusion before exposure of fracture.
5. A retromandibular approach was one of choice to be made. Incision was made 1 cm posterior and parallel to posterior border of ramus of mandible. After skin incision, the parotid gland retracted superiorly and anteriorly. Subcutaneous dissection was proceeding up to stripping masseter muscle off the ramus to expose fracture site.

Fractured segments were reduced into proper anatomical position by inserting stainless steel wire (0.5) in Basel area of angle to act as distracting of ramus exposing area of condyle followed by adaptation of plate and drilling of screw holes using surgical drill (1.8 mm diameter) under constant saline irrigation.

6. Group I Fixation of fractured condyle was accomplished using Two Yang's key hole plates.
7. Group II: Fixation of fractured condyle was accomplished using two miniplates one on posterior border of ramus and the other one parallel to mandibular notch.
8. The occlusion was examined followed by removal of IMF. The eyelets were left for 3 weeks postoperatively in case of complications.

9. Closure of extraoral wound was done in layers.

Using polyglycolic polylactic 3-0 suture material* for deep layers and 4-0 polypropylene suture material** for skin layer.

Postoperative care

Each patient received intravenous ***unasyn 1.5 gm/12 hours for one day postoperatively followed by Amoxicillin/Clavulanate potassium *** * 1 gm twice daily for the next 5 days.

Assessment:

- Clinical
 - Maximal mouth opening
 - Protrusive excursive movement
 - Lateral excursive movement
 - Time for reduction and fixation

Statistical analysis of the data:

Data were fed to computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) The Shapiro-Wilk test was used to verify normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of obtained results was judged at 5% level. The used tests were Student t-test for normally distributed quantitative variables, to compare between two studied groups. ANOVA with repeated measures for normally distributed quantitative variables, to compare between more than two periods or stages, and Post Hoc test (Bonferroni adjusted) for pairwise comparisons. Mann Whitney test for not normally distributed quantitative variables, to compare between two studied groups.

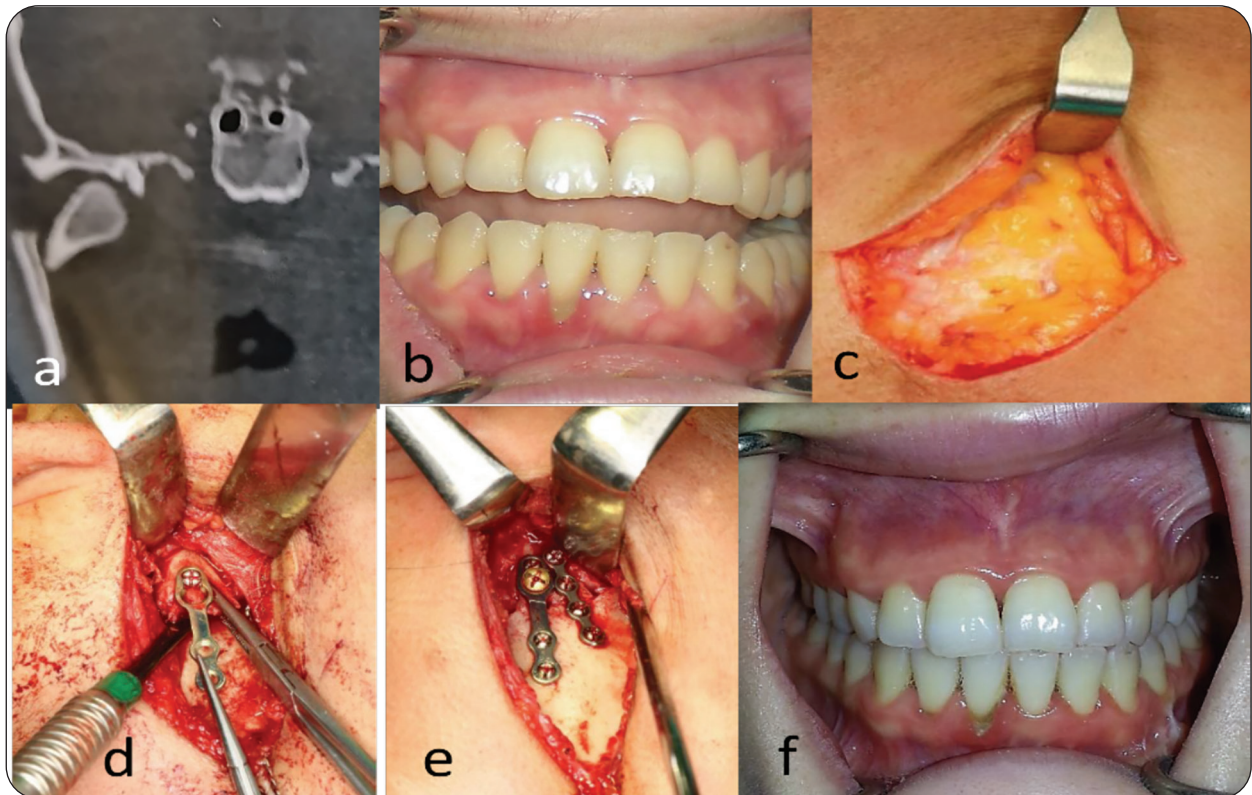


Fig. (1) a, Preoperative 3D C.T showing right medially displaced of subcondylar fracture, b, preoperative occlusion, c, Retromandibular incision, d, Reduction and Fixation by yang key hole plate, e, Fixation by two yang key hole plat., f, Postoperative occlusion after 3 months

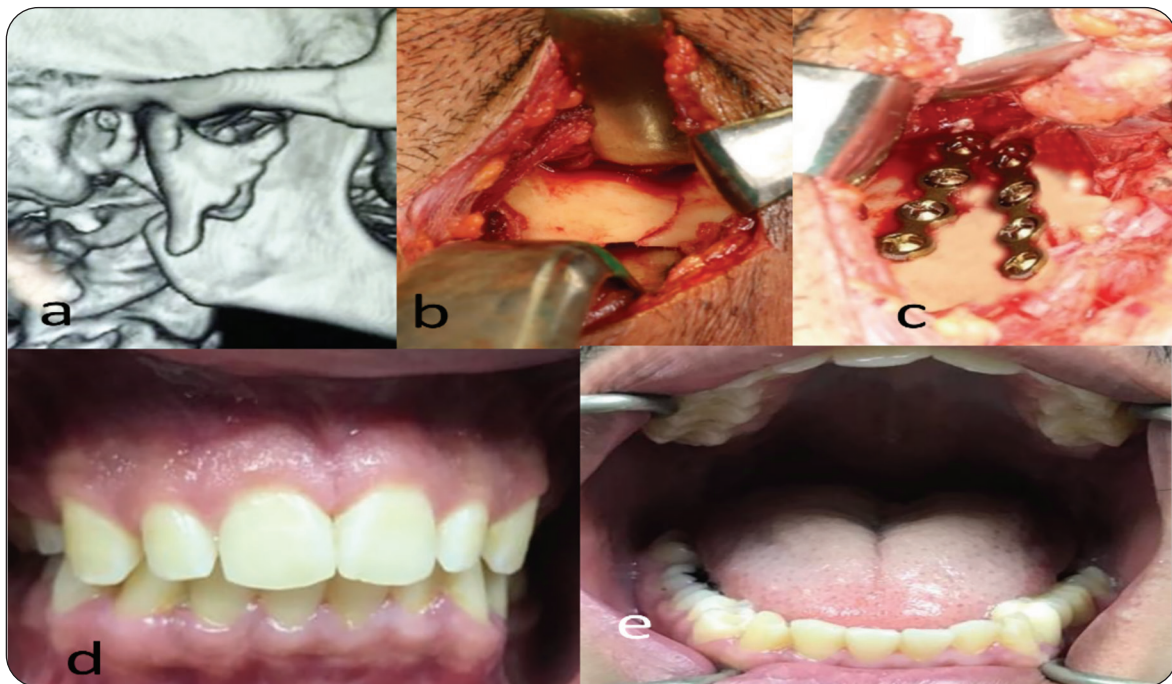


Fig. (2) a, Preoperative 3D C.T showing lateral displacement of subcondylar fracture, b, Reduction of fracture segments after surgical exposure c, fixation by two conventional plate, d, Postoperative occlusion after 3 months, e, Maximal mouth opening after 6 months.

RESULTS

Clinical evaluation:

In group I the mean values of maximum mouth opening range from (22.20±2.82 to 39.10±1.66) and group II range from (21.0±3.77 to 38.50±2.42) at interval 1,3 Weeks and 3,6 Months. At 1st week, 3rd week, 3rd month, and 6th month, there was a statistically non-significant difference between study and control groups (p=0.431, 0.380, 0.182, 0.526 respectively).

In group I the mean values of protrusive excursive movement range from (3.40±0.84 to 8.60 ± 1.26) and group II range from (3.90 ± 0.99 to 8.90 ± 0.74) at interval 1,3 Weeks and 3,6 Months. At 1st week, 3rd week, 3rd month, and 6th month, there was a statistically non-significant difference between

study and control groups (p=0.241, 0.199, 1.000, and 0.525 respectively) in group I the mean values of lateral excursive movement range from (4.40±0.84 to 9.60±0.84) and group II range from (4.50±0.97 to 9.60±0.52) at interval 1,3 Weeks and 3,6 Months. At 1st week, 3rd week, 3rd month, and 6th month, there was a statistically non-significant difference between study and control groups (p=0.809, 0.291, 0.848, and 1.000 respectively).

Mean according to time for reduction and fixation for study group was 23.50±2.46 and mean according to time for reduction and fixation for control group was 31.10±3.35. There was statistically a significant difference between study and control groups (p<0.001*). Study group showed a lower Time for reduction and fixation than control group.

Table (1) Comparison between two studied groups according to maximal mouth opening, Protrusive excursive movement, and Lateral excursive movement.

	Study (n = 10)	Control (n = 10)	t	p
Maximal mouth opening				
1 st week	22.20 ± 2.82	21.0 ± 3.77	0.806	0.431
3 rd week	30.40 ± 2.01	29.70 ± 1.42	0.900	0.380
3 rd month	35.60 ± 3.20	33.70 ± 2.91	1.389	0.182
6 th month	39.10 ± 1.66	38.50 ± 2.42	0.647	0.526
Increase from 1 st week				
3 rd week	8.20 ± 2.66	8.70 ± 2.95	0.398	0.695
3 rd month	13.40 ± 3.75	12.70 ± 1.95	0.524	0.607
6 th month	16.90 ± 3.07	17.50 ± 2.99	0.443	0.663
Protrusive excursive movement				
1 st week	3.40 ± 0.84	3.90 ± 0.99	1.213	0.241
3 rd week	5.70 ± 1.16	6.30 ± 0.82	1.334	0.199
3 rd month	8.20 ± 1.23	8.20 ± 0.92	0.000	1.000
6 th month	8.60 ± 1.26	8.90 ± 0.74	0.648	0.525
Increase from 1 st week				
3 rd week	2.30 ± 0.82	2.40 ± 0.70	0.293	0.773
3 rd month	4.80 ± 1.03	4.30 ± 1.34	0.936	0.362
6 th month	5.20 ± 1.23	5.0 ± 1.05	0.391	0.701
Lateral excursive movement				
1 st week	4.40 ± 0.84	4.50 ± 0.97	0.246	0.809
3 rd week	7.10 ± 1.20	6.50 ± 1.27	1.087	0.291
3 rd month	9.20 ± 1.32	9.30 ± 0.95	0.195	0.848
6 th month	9.60 ± 0.84	9.60 ± 0.52	0.000	1.000
Increase from 1 st week				
3 rd week	2.70 ± 1.16	2.0 ± 0.67	1.655	0.115
3 rd month	4.80 ± 1.40	4.80 ± 0.79	0.000	1.000
6 th month	5.20 ± 1.03	5.10 ± 0.88	0.234	0.818
Time for reduction and fixation				
Mean ± SD.	23.50 ± 2.46	31.10 ± 3.35	5.784*	<0.001*

t: Student t-test p: p value for comparing between two studied groups *: Statistically significant at p ≤ 0.05

DISCUSSION

In the present study clinical and radiological evaluation of patients who had used YK plate, no patient had showed temporomandibular joint dysfunction or any problems related to mouth opening range, infection at operation site, malocclusion, or severe pain. There was no statistically significant difference regarding maximal mouth opening, protrusive excursive movement, lateral excursive movement, vertical height of the ramus, antero-posterior condylar angulation, between study and control groups. However group (I) had showed better and earlier recovery than group (II) this was in accordance with Woo et al.⁽¹⁸⁾ who had assessed clinical outcomes and surgical convenience of a newly designed Yang's Keyhole plate (YK plate) system for treatment of subcondylar and angle fractures of mandible. No critical complications in any of the 22 patients that were treated during 4-months follow-up period. The newly developed YK plate system could be applied to subcondylar and angle fractures of mandible and can provide reliable and convenient application and use.

Cheon et al.⁽¹⁹⁾ had evaluated the long-term stability of YK plate, as a follow-up study, by examining patients who had used YK plate among patients with reduction of mandibular fractures and who seeking for plate removal. He had stated that no patient was complained of joint disease or discomfort moreover the YK plate system had proved to be strong system for getting stable occlusion and provided clinical convenience with no significant difference from conventional plate.

This was in accordance with our results were we had got satisfactory occlusion at the end of present study without any statistically significant difference between both groups.

In current study patients of group (I) had got an average mouth opening of 22.20 ± 2.82 which was increased up to 30.40 ± 2.01 at the end of 3 weeks to gets it's maximum level of 35.60 ± 3.20 at 3 months which was more prominent in results compared to

control group. This was in agreement with Woo et al.⁽¹⁸⁾ who had got similar comparable result in their study after 4 months follow up.

This had been proved in our study resulted where we had got a more improved range of mouth opening since we had followed patients up to 6 months with a reading of 39.10 ± 1.66 mm in study group.

Stability was a crucial factor during process of fracture healing, and surgical interventions, such as internal or external fixation, which were designed to improve stability⁽²⁰⁾. So proper stability could be gained by the use of YK plate in mandibular fracture which could quickly reduce fracture bone segment and fix it to correct position according to surgeon's intention by placing an anchor screw in wide hole at the anterior part⁽²¹⁾. YK-plate could be used to stabilize condylar position with a small modification of anterior hole, such as a sliding-plate, and it was possible to adjust fixation rigidity according to placement of oversized head screw. Moreover, in orthognathic surgery YK-plate can also maintain condylar position through a wide anterior hole. Additionally, if postoperative radiological and clinical examinations showed that occlusion was stabilized, and the condyle was in a stable place, it was possible to obtain long-term stability by self-tapping oversized head screw placement through stab incision under local anesthesia.⁽²¹⁾

Study group (I) had showed a lower time for reduction and fixation than control group (II). When placing conventional plate on surface of bone, an additional fixture should be obtained by using a plate holder, and then a screw could be applied. The dimensions of plate holder itself made surgical field of view narrower. In addition, even when plate was fixed, it often happened that plate was slipped from position to be fixed to another site, thereby increasing operation time. To solve this problem, we had altered shape of hole in plate to the shape of keyhole through which screw head can easily passed. This allowed screw to be applied first before applying plate. After passing through



keyhole part of plate with applied screw, it was slid and then fixed. As a result, the plate was less likely to slip or fall, and unnecessary operation time could be reduced. This was in accordance with Woo et al.⁽¹⁸⁾ who had assessed clinical outcomes and surgical convenience of a newly designed Yang's Keyhole plate (YK plate) system for treatment of subcondylar and angle fractures of mandible. The results had showed that using YK plate system was more convenient and saved time compared to the 4-hole miniplate.

In case of YK plate, it was possible to substitute conventional plate easily because it could be intuitively applied without specialized training if a surgeon had experienced operation using a traditional plate. Another advantage of YK plate was its easier application to substitute conventional plate when conventional plating had failed producing proper stability and met with infection. One of problems that can be expected from YK-plate was structural weakening caused by formation of oversized hole sites. The oversized hole could lead to a breakage of plate at weakened site. FEA had showed that maximum stress concentration occurred at bridge connection not on site of oversized screw which was already planned in the design of YK plate.⁽²¹⁾

Another likely problem was displacement of screw at oversized hole site. In an oversized hole, screw head was seated on plate and displacement was not caused because it was movable following internal shape of hole. In this way, YK-plate had showed stability similar to that of conventional mini-plate and can have advantage of a conventional mini-plate. Besides, it could exhibit a similar effect as sliding-plate and could be firmly fixed depending on whether oversized head screw was placed. Analysis of stress distribution of YK-plate had showed that similar results and effects could be obtained after the SSO using a conventional plate, and it could be used as an alternative fixation method after SSO (21). The YK-plate was thought to be easier to apply in clinical practice while taking advantage of the sliding-plate.⁽¹⁹⁾

Kim et al.⁽²¹⁾ had got similar comparable result which was proved with our study where we had got proper stability with YK plate. Post operative C.T with three dimensional reconstructed images for both groups had showed a proper anatomical reduction of fractured segment while panoramic and posteroanterior views had showed closed reduction and fixation. There was a more accurate anatomical reduction of fractured bone in group (I) than group (II) which was watched with conclusion of Cheon et al.⁽¹⁹⁾ studies who stated that Yang's key hole plate had proved superior results than two plate fixations with easier application, less cost and shorter fixation time.

In summary, this study had showed that reduction of mandibular sub condylar fracture using YK-plate had similar radiological outcomes, fewer clinical complications, and shorter operative time compared to those with a traditional surgical technique, such as rigid fixation. YK-plate was thought to be easier to apply in clinical practice while taking advantage of sliding-plate.

CONCLUSION

Reduction of mandibular condylar fracture using YK-plate had fewer clinical complications, and shorter operative time compared to those with conventional mini plate rigid fixation. The YK-plate was thought to be easier to apply in clinical practice while taking advantage of sliding-plate system.

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AADJ, Vol. 6, No. 2, October (2023) — PP. 277

التقييم الكلينيكي المقارن لشريحة كى هول ينج مقابل الشريحة التقليدية في علاج كسور

لقمة الفك السفلي

على على توفيق* ، اشرف عبدالفتاح محمود ، عبدالعزيز بيومي عبداللله ، محمد محجوب العشماوى

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الملخص :

الهدف: لتقييم استخدام لوحة ثقب المفتاح سريريًا مقارنةً باللوحتين المصغرتين في تثبيت كسور الفك السفلي تحت اللقمة خارج المفصل.

المواد والاساليب: تم تقسيم عشرين مريضاً (16 ذكراً و 4 إناث) الذين استوفوا معايير الاشتمال بشكل عشوائي إلى مجموعتين متساويتين. المجموعة الأولى: تتألف من عشرة مرضى يعانون من كسر تحت اللقمة خارج المحفظة وتم علاجهم باستخدام صفائح ثقب المفتاح يانغ. المجموعة الثانية: تتألف من عشرة مرضى يعانون من كسر تحت اللقمة خارج المحفظة وتم علاجهم بصفيحتين صغيرتين قياسيتين. يتم تقييم المرضى سريريًا عن طريق فتح الفم الأقصى. وحركة التجول الناتئة، وحركة النزهة الجانبية، ووقت التخفيض والتثبيت.

النتائج: أقصى فتح للفم، حركة انحراف بارزة، حركة انحراف جانبية، في الأسبوع الأول، الأسبوع الثالث، الشهر الثالث، والشهر السادس. كان هناك فرق غير مهم إحصائياً بين مجموعات الدراسة والسيطرة.

الخلاصة: كان يعتقد أن لوحة YK هي الأسهل في التطبيق في الممارسة السريرية مع الاستفادة من نظام اللوحة المنزلقة. كان للحد من كسر اللقمة الفك السفلي باستخدام لوحة YK وقتاً جراحياً أقصر مقارنةً بتلك التي تم تثبيتها باستخدام لوحة صغيرة تقليدية.

الكلمات المفتاحية: كسور تحت اللقمة، لوحة ثقب المفتاح يانغ، الشرائح الصغيرة، كسور الفك ، مفصل الفك