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PRS GLOBAL OPEN

ORIGINAL ARTICLE
Craniofacial/Pediatric

Innsbruck-style Retromandibular Anterior Trans-parotid Approach for Condylar Fractures: A Retrospective Review of 39 Fractures

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Background: The retromandibular anterior trans-parotid (RAT) approach and a triangular-positioned double mini-plate osteosynthesis (TDO) technique have been reported from Innsbruck Medical University. This minimally invasive technique involves direct visualization of the condyle and is associated with lower incidence of facial palsy.
Methods: A retrospective review was performed on the RAT approach and TDO technique conducted by a surgeon and team at two hospitals in Tokyo during a period of 3 years and 10 months.
Results: This technique was performed on 35 patients with 39 condylar fractures. Sixty-nine percent of cases were due to accidental fall, 17% to traffic accidents, and 9% to sports. Furthermore, 92% cases were condylar base fractures. Nighty-seven percent of cases achieved good occlusion. The mean maximum mouth opening was 49 ± 1.3 mm. Postoperatively, facial palsy developed in three patients (7.7%), and two of them developed Frey syndrome at approximately 2.5 years postoperatively (5.1%). All patients completely recovered within 3 months postoperatively. One case each of salivary fistula, visible scar, and condylar resorption was found (2.6%). No case of massive bleeding during surgery, hematoma, or TMJ pain after surgery was found.
Conclusion: This technique could achieve good occlusion with low incidence of complications and could contribute to early social reintegration among patients.
(Plast Reconstr Surg Glob Open 2023; 11:e5091; doi: 10.1097/GOX.0000000000005091; Published online 21 June 2023.)

INTRODUCTION

The optimal surgical treatment of mandibular condylar fractures remains controversial[1–6] because (1) surgical treatment is difficult owing to poor visualization during surgery, (2) it may cause postoperative complications including facial palsy,[7] and (3) closed reduction can also achieve good occlusion.[8–10] The Innsbruck-style retromandibular anterior trans-parotid (RAT) approach and a triangular-positioned double mini-plate osteosynthesis (TDO) technique have been reported by Dalla Torre et al. from Innsbruck, Austria. This technique allows direct visualization and is associated with lower incidence of facial palsy.[11] This study reviewed the details of mandibular condylar neck and base fractures treated using the Innsbruck-style RAT approach and TDO technique.

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Received for publication March 13, 2023; accepted May 5, 2023.

Presented at the 64th Annual Meeting of Japanese Society of Oral and Maxillofacial Surgeons (JSOMS) in Sapporo, Japan on October 25, 2019, 73th Annual Meeting of the Japanese Stomatological Society in Kawagoe, Japan on April 24, 2019, and 13th Asian Congress on Oral and Maxillofacial Surgery (ACOMS) in Taipei, Taiwan on November 11, 2018.

Ethical approval was given by the ethics committee of the Tokyo Women's Medical University (reference number 4610-R3) and Tokyo Metropolitan Police Hospital (22-A15).

DOI: 10.1097/GOX.0000000000005091

MATERIALS AND METHODS

A retrospective review of the records, radiographs, and computed tomography scans of patients who had undergone surgery using the RAT approach and the TDO technique between May 2016 and March 2020 was conducted at the department of oral and maxillofacial surgery, Tokyo Women's Medical University Hospital (TWMU), and department of plastic and reconstructive surgery, Tokyo Metropolitan Police Hospital (TMPH) in Tokyo. All cases

Disclosure statements are at the end of this article, following the correspondence information.

were operated by one maxillofacial surgeon and the teams of TWMU or TMPH.

Condylar fractures were classified using the classification method reported by Loukota et al.,[12] including diacapitular (condylar head), condylar neck, and condylar base. The relationship of fractured condyle to the mandible was classified following the method reported by MacLennan[13] in 1949, including (1) fracture deviation, (2) displacement, (3) dislocation, and (4) fracture with no displacement of the condyle. Complications during and after surgery were investigated. Ethical approval was given by the ethics committee of the authors' institutes (reference numbers 4610-R3 and 22-A15).

SURGICAL TECHNIQUE

Mandibular condylar neck and base fractures were treated using the RAT approach and TDO technique. When the contralateral side of the condyle caused the condylar head fracture, it was treated by internal maxillary-mandibular fixation (IMF) for 1–2 weeks after surgery at TWMU, or a dynamic internal distraction device was placed at TMPH.[14] The surgery was performed as follows: (1) Skin incision: a 20- to 25-mm skin incision was made immediately below the ear lobe and parallel to the posterior border of the ramus in the closed-mouth position (Fig. 1). Next, adequate exposure of the superficial musculoaponeurotic system (SMAS) was ensured and then forwarded for anterior dissection on the SMAS. (2) Decision on the perforation point on the SMAS: a perforation point was decided using a nerve stimulator on the SMAS, and the point was marked (Fig. 1). (3) Blunt dissection to the condyle: the SMAS, parotid gland, and masseteric muscle were perforated with blunt curved scissors until the condylar process was reached at the marked perforation point on the SMAS. The perforation point was expanded by various sizes of retractors ranging from narrow to wide. Subsequently, the fracture was exposed.[4] (4) Reduction and fixation: Eckelt/Rasse fracture forceps were placed at the mandibular angle, and the distal segment was pulled by the forceps to the caudal side. The fracture of condyle was restored, one four-hole non-locking mini-plate was placed on the posterior border of the mandible, and temporary IMF was performed. The fracture was fixed by triangular-positioned double mini-plates (two four-hole mini-plates or one four-hole mini-plate and a three-hole mini-plate, and 7- and 5-mm screws were used) on the ideal lines of osteosynthesis. In this technique, the first plate was placed at the posterior boarder, and the second plate was placed at the triangular position on the anterior part on the ideal osteosynthesis line defined by Meyer et al.[15] In principle, more than three screws were placed in the proximal segment of the condyle. (5) Closure of the wound: after osteosynthesis, the SMAS and parotid capsule were closed with 4-0 polyglactin by mattress suturing to prevent parotid fistula formation, and 5-0 polydioxanone dermal suturing and 7-0 nylon suturing on the skin were performed. No drain was placed, and no postoperative IMF was performed. Soft diet was advised for 4 weeks after surgery, and mouth opening exercises were performed 4 weeks after surgery (Figs. 2–10).

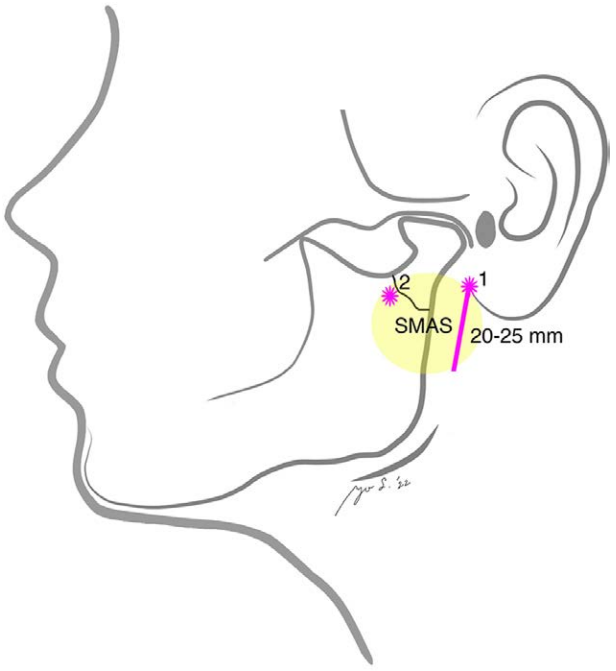

Fig. 1. Schematic of the Innsbruck-style RAT approach. A 20- to 25-mm skin incision was made immediately below the ear lobe (point 1) and parallel to the posterior border of the ramus. After skin incision, the superficial musculoaponeurotic system (SMAS) was exposed and then forwarded to dissect anteriorly on the SMAS (yellow). A perforation point (point 2) was decided by a nerve stimulator on the SMAS. The parotid gland and masseteric muscle were perforated by blunt curved scissors until the condylar process at the perforation point on the SMAS (point 2). The perforation point was expanded by narrow to wide retractors, and the fracture line was exposed.

Takeaways

Question: The optimal surgical treatment of condylar fractures remains controversial because surgical treatment is difficult owing to poor visualization during surgery. It may cause postoperative complications including facial palsy, and closed reduction can also achieve good occlusion.

Findings: Thirty-nine condylar fractures treated by Innsbruck-style retromandibular anterior trans-parotid approach incision were reviewed. Nighty-seven percent of cases achieved good occlusion. Postoperatively, there was no facial palsy at 3 months postoperative, and one case each of salivary fistula and visible scar were found.

Meaning: Innsbruck-style retromandibular anterior trans-parotid approach can achieve good occlusion with low incidence of complications and can contribute to early recovery due to being minimally invasive.

RESULTS

Thirty-five patients with 39 condylar neck or condylar base fractures had undergone surgery using the RAT approach and TDO technique. The mean follow-up period

Fig. 2. Panoramic radiograph findings of the left mandibular condylar base fracture caused by accidental fall in a 40-year-old woman.

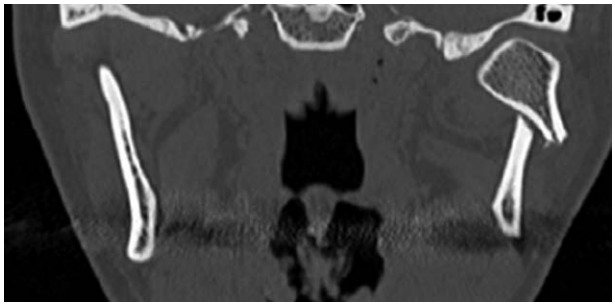

Fig. 3. Coronal computed tomography findings in the left mandibular condylar base fracture with lateral displacement.

was 18 ± 2.5 months (range 19 days to 56 months), the overall male-to-female ratio was 1:1.2, and mean age was 39 ± 2.6 years (range 20–80 years). Sixty-nine percent of cases were due to accidental falls, 17% to traffic accidents, and 9% to sports activity. Overall, 92% of cases were condylar base fractures, 60% were concomitant mandibular fracture, and five cases were combined with condylar head fracture (Table 1). Fractures were treated by IMF for 1–2 weeks after surgery or with placement of a distraction device. Nighty-seven percent of cases achieved good occlusion. One case had malocclusion due to inadequate reduction of concomitant Le Fort I fracture. The mean maximum mouth opening at more than 3 months after surgery was 49 ± 1.3 mm. Postoperative facial palsy was found in three cases (7.7%). Two cases showed a temporal and zygomatic branch weakness, and one case showed slight buccal

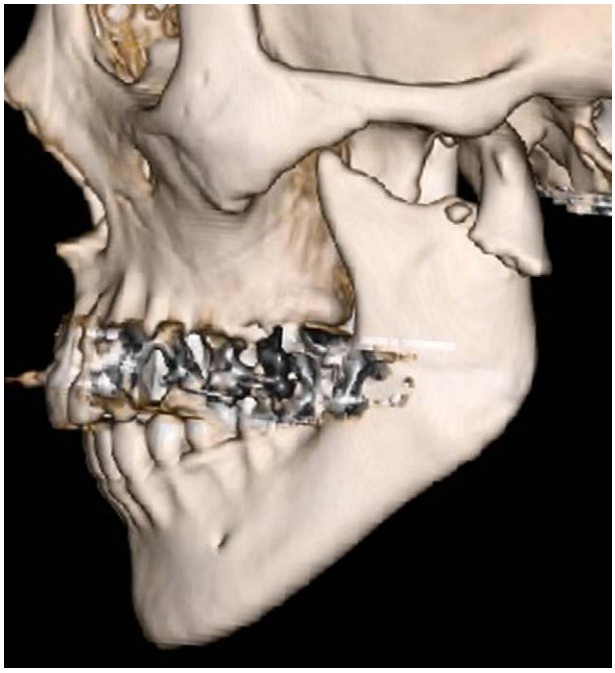

Fig. 4. Three-dimensional computed tomography findings in the left mandibular condylar base fracture with lateral displacement.

Fig. 5. Intraoperative photograph of the internal fixation of left condylar base fracture using the Innsbruck-style RAT approach and a triangular-positioned double mini-plate osteosynthesis technique. The fracture of the condylar base was fixed using two non-locking mini-plates and screws on the ideal lines of the osteosynthesis. In the proximal segment of the condyle, four screws were placed.

Fig. 6. Intraoperative photograph of the wound closure in the Innsbruck-style RAT approach. After osteosynthesis, the superficial musculoaponeurotic system and the parotid capsule were closed with 4-0 polyglactin by mattress suture to prevent parotid fistula, and dermal suturing using 5-0 polydioxanone and epidermal suturing using 7-0 nylon were performed. No drain was placed.

Fig 7. Postoperative panoramic radiograph findings of the left mandibular condylar base fracture treated by the Innsbruck-style RAT approach and a triangular-positioned double mini-plate osteosynthesis technique.

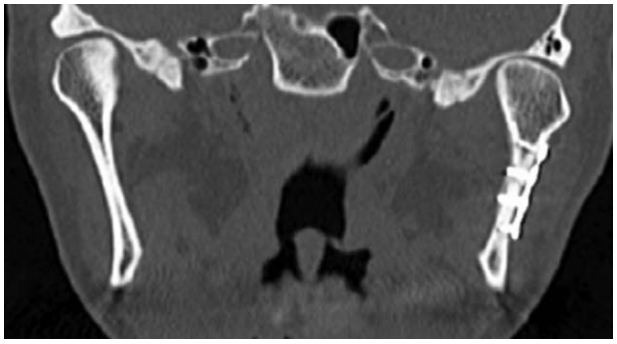

Fig 8. Postoperative coronal computed tomography findings in the left mandibular condylar base fracture treated by the Innsbruck-style RAT approach and a triangular-positioned double mini-plate osteosynthesis technique.

branch weakness. All cases completely recovered within 3 months after surgery. Two of the three facial palsy cases developed Frey syndrome at approximately 2.5 years after surgery (5.1%). Moreover, there was one case of salivary fistula, one of visible scar, and one of condylar resorption[16] (2.6%). However, no massive bleeding during surgery, hematoma, or temporomandibular joint pain after surgery were found. Nine condyles (23%) were treated with plate removal at 11.6 months after surgery (except one case, which underwent plate removal after 13 days due to refracture by epilepsy[17]) (Table 2). The reasons for plate removal were (1) patient's wish (five fractures), (2) tenderness or discomfort on the plate (two fractures), (3) plate fracture (one fracture), and (4) refracture (one fracture).[17]

DISCUSSION

This meta-analysis suggests that open reduction and internal fixation for condylar fractures is as good as or even better than closed reduction.[18] A randomized, prospective, multicenter study suggests that condylar fractures with a deviation of 10 degrees to 45 degrees or shortening of the ascending ramus by 2 mm or more should be treated with open reduction and internal fixation, irrespective of the level of the fracture.[2] Several surgical approaches to the condylar base and lower neck fracture have been reported, including low submandibular/periangular, transparotideal, retromandibular, and high peri-mandibular/modified Risdon-Strasburg approaches.[19] However, a

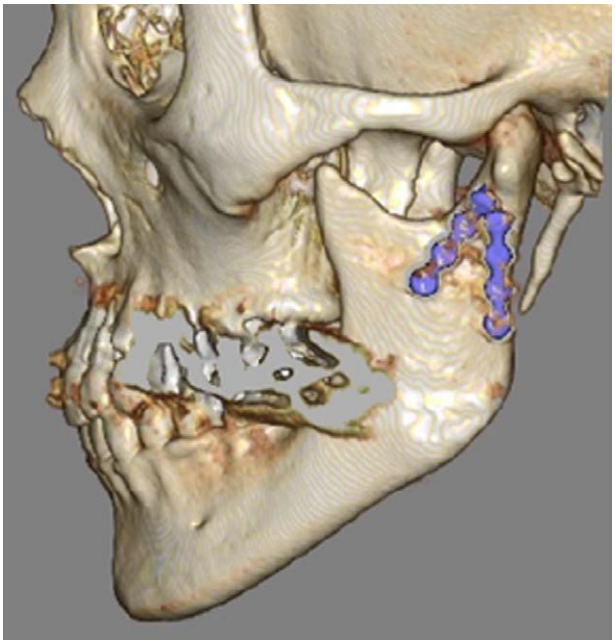

Fig. 9. Postoperative three-dimensional computed tomography findings in the left mandibular condylar base fracture treated by the Innsbruck-style RAT approach and a triangular-positioned double mini-plate osteosynthesis technique.

Fig. 10. Postoperative wound of the left mandibular condylar base fracture 2 years after surgery.

Table 1. Baseline Data of Study Patients

Follow-up Term, Mo (Range)	**17.9 (0.6–46)**
Condylar fractures (n = patients, total n = 35)	
Unilateral	26 (74.3%)
Bilateral	9 (head: 5, neck: 0, base: 4) (25.7%)
Gender	
Male	16 (45.7%)
Female	19 (54.3%)
Mean age (y)	
Overall	38.5 (range 20–80)
Male	37.7
Female	39.2
Mechanism of injury	
Accidental fall	24 (68.6%)
Traffic accident	6 (17.1%)
Sports accident	3 (8.6%)
Other causes	2 (5.7%)
Fracture location (n = fractures, total = 39)*	
Condylar neck	3 (7.7%)
Condylar base	36 (92.3%)
Fracture pattern (n = fractures, total = 39)†	
No displacement	2 (5.1%)
Medial deviation	9 (23.1%)
Lateral deviation	3 (7.7%)
Medial displacement	10 (25.6%)
Lateral displacement	11 (28.2%)
Dislocation and medial displacement	3 (7.7%)
Dislocation and lateral displacement	1 (2.6%)
Associated mandibular fracture (n = patients, total n = 35)	21 (60%)
Associated maxillofacial fracture (n = patients, total n = 35)	5 (14.3%)
Plate removal (n = fractures, total = 39)	9 (23.1%)

*According to Loukota et al.[12]
†According to MacLennan.[13]

previous retrospective multicenter study conducted during 2000–2004 showed that 91% of bilateral condylar fractures and 68% of unilateral condylar fractures are treated by closed reduction in Tokyo.[20] The first author (R.S.) learned this RAT approach and TDO technique reported by Torre et al. during the fellowship at the Innsbruck Medical University in 2014–2015.[21] Minor modifications were performed in this procedure, including wound closure and no drain placement. The authors started this technique at two departments in maxillofacial surgery and plastic surgery in Tokyo approximately 7 months after the first author's fellowship.

In this study, postoperative facial palsy developed in three fracture cases (7.7%) after surgery. Two patients showed weakness of the temporal and zygomatic branch of the facial nerve, whereas one patient showed slight buccal branch weakness. Although marginal mandibular branch (MMB) weakness is most frequently caused in internal fixation of the condylar fracture,[7,23] no case of MMB weakness was found in this study. Moreover, the authors found that using Eckelt/Rasse fracture forceps caused no MMB injury. In this approach, nerve monitoring on the SMAS during surgery detected no MMB, because the incision line immediately below the ear lobe

Table 2. Complications after Surgery (35 Patients, 39 Fractures)

Complications	
Malocclusion, n = patients (%)	1 (2.9)
Mean maximum incisal distance, mm (range)*	49.2 (40–63)
Deviation/deflection, n = patients (%)	4 (11.4)
Facial palsy < 3 mo after surgery, n = fractures (%)	3 (7.7)
Facial palsy > 3 mo after surgery, n = fractures (%)	0 (0)
Parotid fistula/sialocele, n = fractures (%)	1 (2.6)
Massive bleeding during surgery, n = patients (%)	0 (0)
Hematoma, n = fractures (%)	0 (0)
Visible scar, n = fractures (%)	1 (2.6)
Frey syndrome, n = fractures (%)	2 (5.1)
Temporomandibular joint pain, n = fractures (%)	0 (0)
Infection of the wound, n = fractures (%)	2 (5.1)
Plate fracture, n = fractures (%)	1 (2.6)
Condylar resorption, n = fractures (%)	1 (2.6)

*More than 3 months follow-up, except for five unknown cases.

was in a higher position than the general retromandibular approach. All facial palsies completely recovered within 3 months after surgery. Notably, all three cases occurred at the initial year when the authors started this procedure. It is indicated that an immature surgical technique such as excessive retraction of soft tissue was an important risk factor for facial nerve injury in this procedure. Moreover, one case of facial nerve weakness had masseter muscle hypertrophy; it was deeper from the skin to the bone. This increases the difficulty of reduction and fixation processes, and it might induce excessive retraction of soft tissue. Biglioli and Colletti reported difficulty using the mini-retromandibular approach in overweight patients because of the thickness of the soft tissues of the cheek.[24] Another facial nerve weakness case showed condylar neck fracture with medial displacement. It was difficult to perform a reduction and fixation more than the condylar base fracture with lateral displacement, and it might induce excessive retraction of soft tissue. A systematic review indicated that facial palsy occurred in 12% of cases after surgery.[22] The present study showed a lower rate (7.7%) than the previous systematic review; however, facial palsy was noted in 3.9% of cases at Innsbruck[11]; this rate was lower than our study. However, the authors believe the rate of facial palsy would be reduced by accumulation of cases, because no facial palsy was noted since one year after starting this procedure. Interestingly, two of the three cases of postoperative facial palsy developed Frey syndrome at approximately 2.5 years after surgery. They showed sweating around the wound while eating. They showed temporal and zygomatic branch of facial nerve weakness after surgery, and completely recovered 3 months after surgery. One of the three cases of postoperative facial palsy had no Frey syndrome. The authors inquired about symptoms of Frey syndrome via telephone at approximately 6 years after surgery due to the short follow-up period of only 6 months. She showed only slight buccal branch weakness after surgery and completely recovered 3 months after surgery. The most common hypothesis of the cause of Frey syndrome occurs when the regenerating parasympathetic fibers of injured auriculotemporal nerve to salivary glands connect in error with the sweat glands. Latency ranges from 2 weeks to 2 years, but latent periods of greater than 8 years have been reported.[25] The auriculotemporal nerve is a mixed nerve including sympathetic (to sweat glands) and parasympathetic fibers (to salivary glands), and the auriculotemporal nerve is a branch of the mandibular division of the trigeminal nerve, which passes just posterior to the condylar head,[26] followed by the auriculotemporal nerve branch out to the temporomandibular joint.[27] Moreover, limited information is available on whether the auriculotemporal nerve has communicating branches to the temporal branch and buccal branch of the facial nerve.[27] Nonsurgical condylar fractures also cause Frey syndrome due to auriculotemporal nerve injury.[26] It is indicated that soft tissue excessive retraction at the high level of the condyle (around the condylar head) might cause both temporal branch, zygomatic branch of the facial nerve, and temporoauricular nerve injury, as in these two cases of Frey syndrome.

In this study, malocclusion was found in one case (2.9%) after surgery. One case of bilateral condylar base fracture, symphysis, Le Fort I, and zygomatic fracture showed malocclusion due to inadequate reduction of the Le Fort I fracture. When the authors found malocclusion after surgery, they performed elastic traction. This did not improve the occlusion; however, prosthetic treatment of several fractured molars has improved occlusion. Although the occlusion was stable, unilateral plate fracture was found at 4.5 months after surgery. Plate removal was performed at 12 months after surgery.

To achieve no visible scar after surgery, the authors changed the suture technique from the original Innsbruck technique for Asian patients because it was known that Asian patients have higher prevalence of keloid and hypertrophic scars than White patients.[28] The authors used a thinner stitch; for dermal sutures, 5-0 polydioxanone was used, and for epidermal sutures, 7-0 nylon was used. In this study, most wounds (97%) were not visible, and the patients never complained regarding the scar. However, a visible scar was found in one condyle (2.6%) after surgery, and the patient showed a reddish scar after surgery. She had undergone plate removal and scar revision 1 year after internal fixation. However, the reddish scar recurred, and it got gradually swollen and expanded, and became a 9-mm-wide reddish scar 32 months after internal fixation. Although the cause was not clear, her constitutional factor might cause hypertrophic scar,[28] and additionally, the string of her mask was always attached to the wound below the earlobe during the COVID-19 pandemic, which might induce a hypertrophic scar. Three other cases noted a partially wide scar, although they were not visible; one male patient had a partial 4-mm-wide scar; however, it was flat and without redness. The partial wide scar might be caused by a burn injury during osteosynthesis. One woman had a partial 6-mm-wide scar that was flat and without redness. She had a suture abscess at 1 month after surgery, which might have caused the partial wide scar. One woman with bilateral fractures had a bilateral flat wide scar, although the cause was not clear.

A salivary fistula was found in one condyle (2.6%) after surgery. The patient showed buccal swelling after surgery, and sialocele was suspected. Three weeks after surgery, sialocele was ruptured with infection and resulted in a salivary fistula. The salivary fistula was seen with no complications at 2 weeks. No plate removal was necessary, and the scar was not visible. To prevent a salivary fistula, the authors changed the suture technique from the original Innsbruck technique; SMAS/parotid capsule was closed by mattress suture with no drain placement. Ellis and Zide described that closure of the parotid capsule/SMAS and platysma layer is important to avoid a salivary fistula. A running, slowly resorbing horizontal mattress suture was used to tightly close the parotid capsule, SMAS, and platysma muscle in one water-tight layer.[29] Although no drain was placed, no case of hematoma was found in this study.

In this study, in eight cases, nine condyles (23%) underwent plate removal. The reasons for the plate removal were patient's wish (five condyles), tenderness or discomfort on the plates (two condyles), plate fracture due to malocclusion following the inadequate reduction of the Le Fort I fracture (one condyle), and refracture (one condyle).[17] One patient had a refracture due to epileptic seizure at 6 days after surgery. The patient drank a lot of alcohol the day before. The fracture line ran on the upper screw of the posterior plate. Plate removal was performed because the proximal segment of the condyle could not be repositioned.[17] Plate removal following maxillofacial trauma is still controversial.[30–32] The authors recommend removing the plates when tenderness or discomfort on the plate is shown. Graillon et al reveal that mini-plates impact the biomechanical behavior of the mandible, resulting in more complex fractures in a cadaver experimental study using a Charpy pendulum impact machine.[33] Patients with potential risk of refracture might also require removal of the plates, such as in fighter and epilepsy patients.

Currently, minimally invasive surgery is preferred because small incisions may provide less surgical trauma, less bleeding, fewer and smaller scars, reduction in infection risk, and shorter hospital stays.[34] There are reports of minimally invasive surgery for condylar fractures as a mini-retromandibular approach using a 20- to 25-mm incision.[24,34–38] Colletti et al treated condylar fractures at every level (from high-neck to low-subcondylar fractures) using the mini-retromandibular approach. This broad application is possible because the view is limited by the deeper part of the access and not the skin incision.[37] In this technique, a 20- to 25-mm incision could approach condylar fractures at the level from the neck to base and coronoid. The authors started this procedure in 2016. The surgeon could have a good view of the fractured condyle via the 20- to 25-mm incision; however, assisting surgeons could not see fracture site in this procedure. Thus, when the authors started this approach, the soft tissue must have been excessively retracted by the assisting surgeon due to bad visualization. Excessive retraction of the soft tissue induced facial nerve injury. It is important that the surgery team has a common understanding of which retractor should always be placed on the bone, and avoid excessive retraction of the soft tissue to prevent facial nerve injury. The access to the condyle was narrow, and the soft tissues had to be retracted to prevent soft-tissue injury during drilling.

The authors performed the TDO technique reported by Torre et al.[11] In this technique, the first plate was placed at the posterior boarder, and then the second plate was placed at triangular position on the anterior part on the ideal osteosynthesis line defined by Meyer et al.[15] The TDO mini-plate osteosynthesis technique contributed not only to fixation but also to reduction of the fracture. For example, the first mini-plate was placed at the proximal segment of the condyle, and then the plate was pulled, and reduction was performed; pulling the second plate corrected the anterior gap of the fracture.

This technique can contribute to early recovery due to being minimally invasive. A professional football goalkeeper patient with condylar base and symphysis fractures started moderate exercise 5 days after surgery, and progressively full exercise without contact was started 8 days after surgery. The patient started normal team training 4 weeks after the surgery. Although he had a weight loss of 2.2 kg 1 week after surgery, his weight was regained at 4 weeks after surgery.[39] Moreover, a 27-year-old woman had a unilateral condylar base fracture due to a fall, 5 days before her wedding. She decided to undergo internal fixation by this procedure and completed the wedding on schedule 4 days after surgery.

CONCLUSIONS

The Innsbruck-style RAT approach and TDO technique for condylar fractures can achieve good occlusion and low incidence of complications. The TDO mini-plate osteosynthesis technique contributed not only to fixation but also to reduction of the fracture. It can contribute to early social reintegration for patients.[39]

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

ACKNOWLEDGMENTS

The authors thank AO Foundation, Prof. M. Rasse, Prof. W. Puelacher and all the staff at Universitätsklinik für Mund-, Kiefer- und Gesichtschirurgie, Innsbruck for their kind support and assistance in fellowship of the first author R.S. The authors also thank Prof. T. Ando (TWMU) and Dr. T. Akizuki (TMPH) for their kind support for starting the RAT approach as a novel approach to the condylar fractures in Japan, and Dr. K. Kuribayashi (Hokkaido University), Dr. M. Kumagai, Dr. Y. Yanagisawa, and Dr T. Kurobane (Tohoku Kosai Hospital) for their kind support in the follow-up of the patients.

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