ORIGINAL ARTICLE

The synergy between endoscopic assistance and extraoral approach in subcondylar fracture repair: a report of 13 cases

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ABSTRACT

BACKGROUND: We aimed to present the primary experience of one surgeon with a new surgical technique performed on the first 13 cases and to evaluate outcomes following an extraoral endoscopic approach to subcondylar fractures.

METHODS: Fifteen subcondylar fractures in 13 patients, who were treated at Ondokuz Mayis University Hospital between January 2010 and June 2011, were included in this study. Patients were operated on using either endoscopic or open approach.

RESULTS: Rigid plate fixation was completed endoscopically using extraoral approach in nine fractures, while six fractures were plated by conversion to a full-open approach. In all six fractures that could not be fixed endoscopically, the proximal fragments were medially displaced, whereas seven of nine fractures that were successfully fixed endoscopically were laterally displaced.

CONCLUSION: An extraoral endoscopic approach for subcondylar fractures is feasible and can be carried out with decreased morbidity. This approach is recommended for those with limited experience in endoscopy to treat low laterally displaced subcondylar fractures as their initial cases.

Key words: Endoscopy, endoscopic assistance, subcondylar fracture, subcondylar fracture treatment.

INTRODUCTION

Subcondylar fractures of the mandible are common and account for 9-45% of all mandibular fractures; treatments for these fractures remain controversial.[1-8] Although closed reduction and maxillomandibular fixation is the method most widely employed to treat subcondylar fractures, accurate reduction of the fracture and anatomically restoring condylar position are rarely achieved. Open reduction and internal fixation (ORIF) is a reliable method for anatomical restoration of condylar position and for minimizing the risk of malocclusion, internal derangement and degenerative osteoarthritis.[9] However, ORIF has some major drawbacks, such as poor access and visualization, facial nerve deficits, facial scarring, salivary fistulas, and delayed functional rehabilitation. Many open subcondylar fracture repair techniques to minimize these limitations and complications have been described.[3]

The endoscopic approach to the repair of subcondylar fractures was first described by Jacobovicz et al. in 1998.[9] Subsequently, this minimally invasive technique was advocated by many authors for fracture management with a potential for decreased patient morbidity.[10]

Endoscopic subcondylar fracture repair has evolved to achieve equivalent or superior results with decreased morbidity. Compared with open techniques (preauricular approach), the endoscopic approach to the condylar region remains extracapsular and does not affect cartilage or synovial fluid.[11] The purpose of this study was to present the primary experience of one surgeon with an endoscopic surgical technique performed on the first 13 cases and to evaluate outcomes following an extraoral endoscopic approach to subcondylar fractures.

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MATERIALS AND METHODS

This study was approved by the Ondokuz Mayis University Hospital Institutional Review Board, and all participants signed an informed consent agreement. Fifteen subcondylar fractures in 13 consecutive patients, who were treated at Ondokuz Mayis University Hospital between January 2010 and June 2011, were included in this study. All operations were performed by one surgeon (LE). The total follow-up period for patients was 18 months.

Ten males (77%) and three females (23%), with an age range of 23-59 years, were included. The mechanisms of the fractures included falls (6 cases), motor vehicle accidents (6 cases), and assault (1 case). Two patients had bilateral subcondylar fractures. The subcondylar fractures were dislocated medially in seven cases and laterally in the remainder. Ten patients had concurrent facial fractures (Table 1).

The main findings in the cases diagnosed as subcondylar fractures were pain, malocclusion, open bite, and mandibular asymmetry. Localization and type of fractures, degree of displacement, and the presence of additional facial fractures were evaluated by panoramic radiographs and computed tomography (CT) scans. The procedures were performed under general anesthesia using endoscopic instruments (30° angled 4-mm diameter straight endoscope). Five of the 15 fractures were explored using two ports (submandibular and intraoral), whereas nine were explored through a single submandibular port. One fracture was explored by using a previous laceration.

Surgical Technique

It is recommended that the patient be in the supine position and nasotracheally intubated. This positioning allows the surgeon and assistant to stand on either side of the head of the patient.

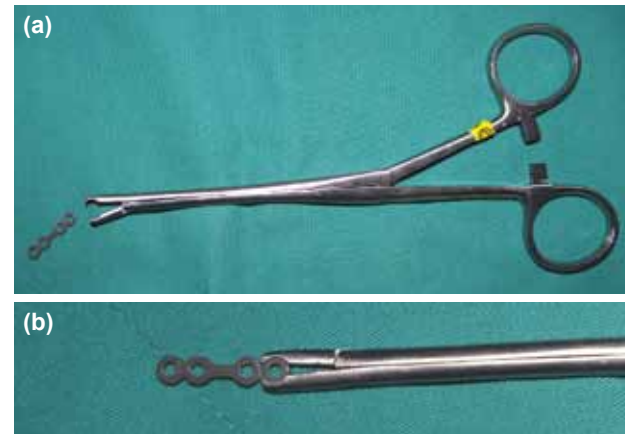

Figure 1. (a) Our specially designed plate holder clamp. **(b)** The head part of the clamp is compatible with the plate. This enables the surgeon to perform fine manipulations with great ease.

Visualization requires an endoscope and a camera attachment. The endoscopic view is projected on a video monitor that can be viewed by both the surgeon and the assistant. The surgeon should also have access to appropriate instrumentation. Some specialized instruments have been designed specifically to facilitate this procedure (Fig. 1a, b).

Arch bars were applied (if the patient was dentate) for postoperative occlusal training and mandibulomaxillary fixation (MMF). If there were any other fractures in the mandible, these were repaired first. All of our endoscopic surgery was performed using a submandibular incision combined with an intraoral incision in initial cases. A preauricular incision was used for the open reductions (bail out procedure) (Table 2).

Table 1. Patients with concurrent facial fractures

No	Age	Fracture	Dislocation	Concurrent fracture
1	38	Left→Subcondylar Right→Subcondylar	Right→Medial Left→Lateral	Yes
2	56	Left→Subcondylar	Lateral	No
3	38	Right→High subcondylar	Medial	Yes
4	26	Right→Subcondylar	Lateral	Yes
5	47	Left→Subcondylar	Lateral	Yes
6	23	Left→Subcondylar	Medial	Yes
7	24	Left→Subcondylar	Lateral	No
8	32	Right→Subcondylar	Medial	Yes
9	24	Right→Subcondylar Left→Subcondylar	Right→Medial Left→Lat	Yes
10	44	Right→Subcondylar	Lateral	No
11	49	Left→Subcondylar	Medial	Yes
12	59	Right→Subcondylar	Lateral	Yes
13	45	Left→Subcondylar	Medial	Yes

Table 2. Bail-out procedure

No	Incision(s)	Operation Type(s)	Mini-plate(s)
1	Right→Submandibular-Intraoral	Right→Endoscopic-Open	Right (1)
	Left→Submandibular-Preauricular	Left→Endoscopic	Left (1)
2	Submandibular	Endoscopic	1
3	Submandibular-Preauricular	Endoscopic-Open	2
4	Submandibular-Intraoral	Endoscopic-Open	1
5	Submandibular-Intraoral	Endoscopic-Second	2
6	Submandibular-Intraoral	Endoscopic	2
7	AN (own incision)	Endoscopic	2
8	Submandibular-Intraoral	Endoscopic	1
9	Right→Submandibular, Preauricular	Right→Endoscopic-Open	Right (1)
	Left→Submandibular	Left→Endoscopic	Left (2)
10	Submandibular	Endoscopic	1
11	Submandibular-Preauricular	Endoscopic-Open	1
12	Submandibular	Endoscopic	1
13	Submandibular-Preauricular	Endoscopic-Open	1

After the injection with a hemostatic agent, 1% lidocaine with 1:100.000 epinephrine, a 1.5-2 cm incision was made one finger-breadth below a line from the mandibular angle. The angular part of the mandible was dissected meticulously using a fine-tipped scissor to protect the marginal mandibular nerve. A blind subperiosteal dissection was then performed to create an optical cavity. A lag screw was passed through a 1.5-mm drill hole at the mandibular angle to allow the surgeon to distract the distal segment. The fracture lines were identified endoscopically. A long-handled, narrow-tipped clamp was used to grasp the condylar neck and to position the condylar head in the fossa. After ensuring that the fractures were reduced, fixation was achieved by placing titanium mini-plates and screws via a preauricular stab incision and trocar.

RESULTS

Fifteen subcondylar fractures were explored in 13 patients using an endoscopic approach. Two of the 13 patients had bilateral fractures. Rigid plate fixation was completed endoscopically in nine fractures (Fig. 2); six fractures that could not be reduced endoscopically were plated by conversion to a full-open approach (bail-out procedure). According to the postoperative radiographs, only one endoscopically operated case had inadequate reduction on one side. That patient underwent re-fixation three days later, which ultimately resulted in a successful functional outcome with normal occlusion as with the remaining endoscopically fixed fractures.

Mandibulomaxillary fixation (MMF) was used for 14 days in six cases in whom stabilization was questionable. All patients in this series ultimately developed normal occlusion and function.

In all six fractures that could not be fixed endoscopically, the proximal fragments were medially displaced, whereas seven of nine fractures that were successfully fixed endoscopically were laterally displaced. Two fractures that were fixed endoscopically were minimally medially displaced. Ten subcondylar fractures were fixed with one mini-plate. Five cases underwent fixation with two mini-plates (Table 2).

The mean operating time was 150 minutes (min), including MMF.

Panoramic radiographs and CT scans (coronal, axial, and three-dimensional CT) were taken postoperatively. Adequate consolidation of the fracture was observed in all patients at the end of the follow-up period (Fig. 3).

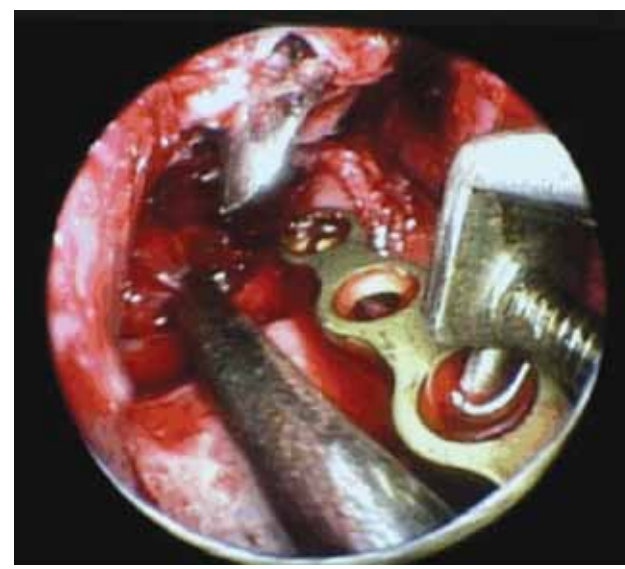

Figure 2. Endoscopic assistance in rigid plate fixation.

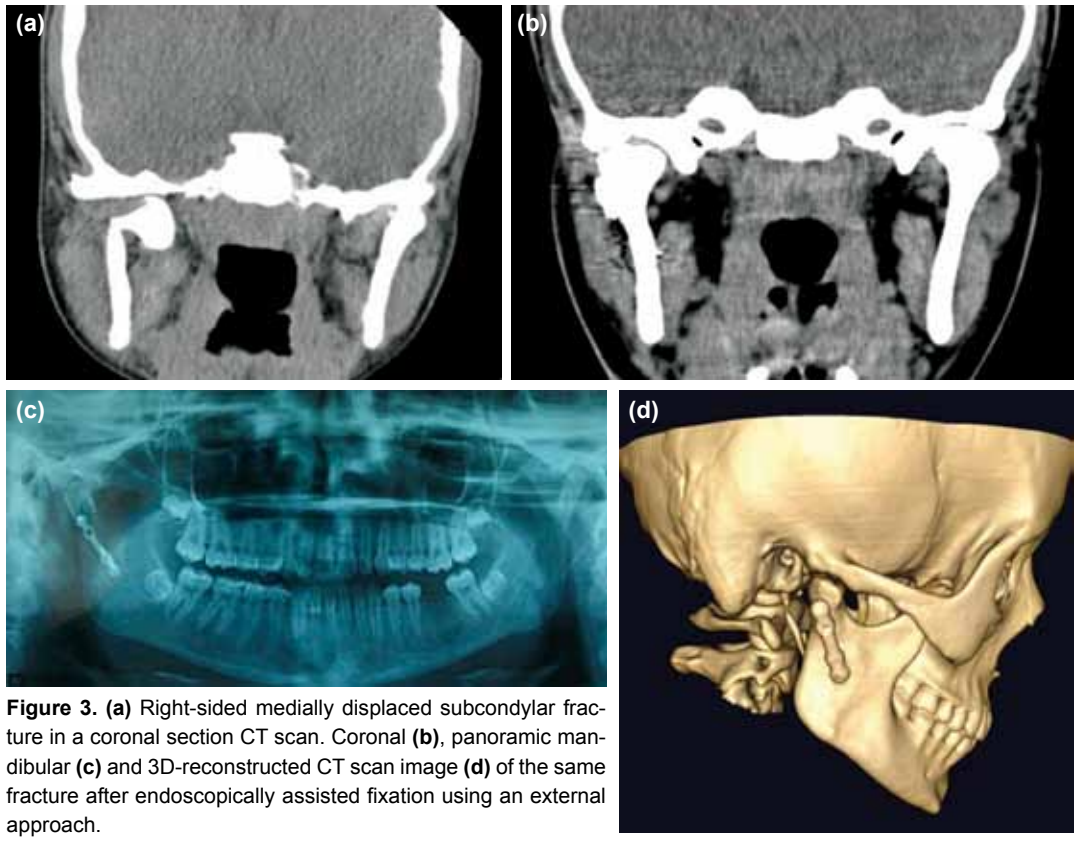

Figure 3. (a) Right-sided medially displaced subcondylar fracture in a coronal section CT scan. Coronal **(b)**, panoramic mandibular **(c)** and 3D-reconstructed CT scan image **(d)** of the same fracture after endoscopically assisted fixation using an external approach.

Facial nerve weakness was detected in two of six patients who underwent open technique (33%) and in one of nine cases who underwent endoscopic technique (11%). Normal nerve function had recovered before the postoperative 5th month in these patients in both groups. One patient (7%) who underwent open technique developed a visible scar. The mean maximal interincisal mouth opening was 42.28 mm in endoscopically assisted operations. Three patients had a temporomandibular joint (TMJ) click; two of them had undergone an open technique. Three patients who underwent open technique complained of a persistent headache and one patient complained of TMJ pain (Table 3).

Table 3. Complications

No	TFNW	Vs	MO (mm)	Click	Headache	TMJ Pain	Operation technique
1	No	No	40	Yes (Right)	No	No	Right→Endoscopic-Open, Left→Endoscopic
2	No	No	39	No	No	No	Endoscopic
3	Yes	Yes	38	No	Yes	No	Endoscopic-Open
4	No	No	46	No	No	No	Endoscopic-Open
5	No	No	46	No	No	No	Endoscopic
6	Yes	No	43	Yes	No	No	Endoscopic
7	No	No	44	No	No	No	Endoscopic
8	No	No	41	No	No	No	Endoscopic
9	Yes (Right)	No	53	No	Yes (Right)	Yes (Right)	Right→Endoscopic-Open, Left→Endoscopic
10	No	No	40	No	No	No	Endoscopic
11	No	No	42	No	Yes	No	Endoscopic-Open
12	No	No	43	No	No	No	Endoscopic
13	No	No	44	Yes	No	No	Endoscopic-Open

TFNW: Transient facial nerve weakness; Vs: Visible scar; MO: Mouth opening; TMJ Pain: Temporomandibular joint pain.

DISCUSSION

The criteria for successful treatment of mandibular subcondylar fractures include reestablishment of preinjury occlusion, pain-free jaw opening of ≥40 mm, good excursion of the jaw in all directions, minimal facial scarring, and facial symmetry.[12,13] The indications for open reduction or nonsurgical treatment remain controversial, and closed reduction remains the most widely used method.[3,6,8] Although superior functional outcomes following anatomical reduction compared with nonsurgical treatment have been reported for displaced fractures,[3,4,7,8] there is a relatively high risk of injury to the facial nerve, poor access and visualization, facial scaring, salivary fistulas, and delayed functional rehabilitation.[3,14,15] Endoscopic techniques using limited incisions have been described to minimize complications related to a surgical approach. Minimally invasive techniques achieve equivalent or superior results with decreased morbidity when compared with standard techniques.[12,16-25] Five of our patients who were operated on using open technique had pain (headache or TMJ pain) or TMJ click, while one patient in whom endoscopic approach was used had TMJ click (Table 3). This might be due to the endoscopic approach, which remains extracapsular and does not affect cartilage or synovial fluid.[11] Two endoscopic techniques to approach subcondylar fractures have been developed.[27] One technique uses an intraoral incision followed by a dissection along the mandibular ramus.[16-22] The second technique uses an incision inferior to the mandibular angle as a mini-Risdon type of approach.[24-27] Kellman[20] and Mueller et al.[23] reported the technical details of endoscopic approaches. Kellman also described the main incisions (intraoral and submandibular) as major ports; that is, a larger incision through which endoscopic visualization is performed.

Transoral approaches have been used with great success to treat subcondylar fractures.[16,17,19,21,22,29-34] The transoral approach, which is minimally invasive, can reduce a subcondylar fracture without facial scarring or facial nerve injury. Troulis and Kaban described an extraoral endoscopic approach to manage subcondylar fractures.[25] They reported that a submandibular incision significantly reduces dissection, bleeding, and swelling, and they suggested that this allows better visualization and a more comfortable orientation, making the learning curve of the procedure shorter than that for the intraoral approach.[25,26] The major advantage of the intraoral approach is the lack of facial scarring and facial nerve palsy, whereas the major disadvantage is less visualization. Kellman stated that alignment of the posterior border is a reliable finding for a fracture reduction that can be evaluated more precisely via a submandibular approach.[20]

In our initial cases, we used intraoral incisions as a major port. However, achieving the proper orientation to reduce the fracture was challenging; thus, we used a submandibular incision as a second major port. In later cases, it was decided to use a submandibular incision as the major port, which allows for significantly better visualization and orientation. None of the patients developed permanent facial nerve palsy, and only one case of transient nerve weakness occurred. As application of endoscopic assistance reduced the size of the required incision, the final scar with regard to external approach was smaller.

The direction of the proximal fragment displacement is an important factor when assessing the applicability of intra- or extraoral approaches. Chen et al.[16] reported that endoscopic subcondylar fracture repair is particularly easy to perform in patients presenting with lateral override at the fracture site. In contrast, a medial override subcondylar fracture is particularly difficult to repair. Mueller[12] reported that lateral displacement of the proximal segment is the most favorable for endoscopic repair of subcondylar fractures and that medial override of the proximal fragment is considered a contraindication. Schön et al. treated 17 patients using both intra- and extraoral approaches and reported that the intraoral approach was a reliable method for reducing fractures, even laterally displaced subcondylar fractures. He stated that the extraoral approach is indicated for severely dislocated fractures and medially displaced subcondylar fractures. In view of this knowledge, we still employed extraoral approach in cases with lateral displacement. The main cause for this otherwise "over precise" way of fixing subcondylar fractures was our desire to synergize the advantages of endoscopic assistance with the abilities of an extraoral approach.

Limited angulation and minimal medial overriding of the proximal fragment can be reduced endoscopically. We achieved reduction of medially displaced subcondylar fractures in two cases. One case had limited medial displacement and the other had minimal overriding of the proximal fragment. Many authors use an intraoral approach to treat medially displaced subcondylar fractures. However, the intraoral approach has not been adopted as a routine technique due to its higher technical difficulty compared to extraoral approaches, which also provide better visibility.[18,22,33] In fact, whatever method is used, the endoscopic approach is technically challenging, and there is a steep learning curve. Medially displaced subcondylar fractures in six patients could only be plated after conversion to a full open approach as a bail-out procedure, and one endoscopically operated case with inadequate reduction on one side was subsequently reoperated.

Troulis and Kaban[25] reported 60 min and Lauer and Schmelzeisen[24] reported 210 min for conducting the extraoral approach. Using an intraoral approach, Miloro[11] and Lee et al.[16] reported 109±32 and 143±63 min, respectively. The mean operating time in our cases was 150 min. These operation times are shorter than those of open reduction for subcondylar fracture treatment. In fact, the difficulty of fracture reduction in a limited two-dimensional visual field and the long

learning curve are the major drawbacks of endoscopy for subcondylar fractures. Kellman[35] pointed out that once experience has been gained, the procedure can be performed in a reasonable amount of time. The use of specialized equipment also seems to be a disadvantage of the endoscopic technique as monitors, light sources, and other equipment are currently available in most operating rooms. However, proper instruments such as retractors, plate holders and specific trocars are important for successful completion of the entire procedure.

The 1.5-mm mini-plates were used for fracture reduction because they allow a particular degree of malleability during adaptation. Two plates were utilized for fracture stabilization if possible. MMF was performed 14 days later in six cases in whom fracture stability was questionable.

In conclusion, an extraoral endoscopic approach for subcondylar fractures is feasible and can be carried out with decreased morbidity. This approach is recommended for those with limited experience in endoscopy to treat low laterally displaced subcondylar fractures as their initial cases, and the extraoral approach can be used as the major port.

Conflict of interest: None declared.

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KLİNİK ÇALIŞMA - *ÖZET*

Mandibular subkondil kırıkların onarımında endoskop yardımı ve ağız dışından yaklaşımın sinerjisi: 13 olgu deneyimi

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AMAÇ: Maksillofasiyal travma tek başına veya diğer travmalara eşlik edecek şekilde görülebilir. Bu travmalarda mandibula kırığı görülme oranı yüksektir. Mandibulanın tüm kırıkları arasında subkondil bölgesine ait kırıklar özel bir yaklaşım gerektirir. Açık redüksiyonla yapılan internal sabitlemelerde; yüzde istenmeyen skar oluşumu, geçici/kalıcı fasiyel sinir felci gibi ek morbiditeler oluşabilir. Subkondil kırıklarında endoskopik yaklaşımla bu sorunları azaltmak mümkündür.

GEREÇ VE YÖNTEM: Çalışmamızda birbirini takip eden 13 hastadaki subkondil kırıklarına ağız dışından endoskopik yaklaşımla gerçekleştirdiğimiz onarımlara ilişkin tecrübelerimizi aktarmayı amaçladık. Ocak 2010 ve Haziran 2011 tarihleri arasında Ondokuz Mayıs Üniversitesi Tıp Fakültesi Hastanesi Plastik Rekonstrüktif ve Estetik Cerrahi Kliniği'ne acilden başvuran 13 hastadaki 15 subkondiler kırık bu çalışmaya dahil edildi.

BULGULAR: Hastalara endoskopik veya açık yaklaşım kullanılarak girişimde bulunuldu. Kırıklardan dokuz tanesine ağız dışından yapılan endoskopik yaklaşımla başarılı biçimde plak-vida sabitlemesi yapıldı. Endoskopik onarım yapılan kırıkların yedi tanesinde proksimal parçalar laterale deplaseydi. Kırıkların geri kalan altı tanesine ise endoskopik olarak başlandıktan sonra tam açık yaklaşıma dönülerek girişim yapıldı. Bu altı kırığın hepsinde de proksimal parçalar mediyale deplase haldeydi.

TARTIŞMA: Subkondil kırıklarında ağız dışından endoskopik yaklaşımla onarım yapmak mümkündür. Bu yaklaşımda amaç işleme bağlı ek morbiditeyi etkili biçimde azaltmaktır. Endoskopik cerrahi ile tecrübesi az olan meslektaşlarımıza tavsiyemiz başlangıç olgusu olarak laterale deplase olmuş düşük seviyedeki subkondil kırıklarını seçmeleridir.

Key words: Endoskopi, endoskopik asistans, subkondiler kırık, subkondil kırığı.

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