CLINICAL FOLLOWUP OF PATIENTS TREATED FOR CONDYLAR FRACTURES BY A TRANSPAROTID APPROACH

Dissertation submitted to

THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment for the Degree of

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BRANCH III

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RAJA NAGAR, KAVALKINARU - 627 105, TIRUNELVELI DISTRICT.

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Affiliated to The Tamil Nadu Dr. M.G.R. Medical University, Chennai.

DEPARTMENT OF ORAL AND MAXILLOFACIAL SURGERY

CERTIFICATE

This is to certify that this dissertation entitled "Clinical followup of patients treated for condylar fractures by a transparotid approach" is a genuine work done by **Dr.Varun.M** under my guidance during his post graduate study period 2010-2013.

This Dissertation is submitted to THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY in partial fulfillment for the Degree of **MASTER OF DENTAL SURGERY IN ORAL AND MAXILLOFACIAL SURGERY, BRANCH III.** It has not been submitted (partial or full) for the award of any other degree or diploma.

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This ethical committee has undergone the research proposal/protocol submitted by Dr. VARUN.M Post Graduate Student, Dept of ORAL AND MAXILLOFACIAL SURGERY, under the title CLINICAL FOLLOWUP OF PATIENTS TREATED FOR CONDYLAR FRACTURES BY A TRANS-PAROTID APPROACH under the guidance of Dr. M.BASKARAN MDS, FDSRCS (ENG) for consideration of approval to proceed with the study.

This committee has discussed about the material being tested / patients participating / experimental animals / involved with the study, the qualification of the investigator, the present norms and recommendation from the Clinical Research scientific body and comes to a conclusion that this research protocol fulfills the specific requirements and the committee authorizes the proposal.

I. E. C. & R. B. RAJAS DENTAL COLLEGE & HOSPITAL ETHICAL COMMITTEE & REVIEW BOARD

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Dedicated To

Amma, Appa and dear Sister

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LIST OF ABBREVIATIONS USED

RTA	-	Road traffic accidents
ORIF	-	Open reduction and internal fixation
SS	-	Stainless steel
VAS	-	Visual analog scale
IMF	-	Intermaxillary fixation
SMAS	-	Superficial musculoaponeurotic system
CT	-	Computed tomography
OPG	-	Orthopantomogram

CONTENTS

ABSTRACT

Background: Since ages human race have been genuinely concerned about their facial appearance. Mandibular prognathism (MP) or skeletal Class III malocclusion is one of the most severe maxillofacial deformities resulting in aesthetic concerns and also affect the normal functional abilities of an individual and disturbing psychological problem. One of the characteristic features of mandibular prognathism is obtuse gonial angle. In ensuring an esthetic harmonious facial profile, gonial angle plays an important role. Surgical treatment of the mandibular prognathism either Bilateral Sagittal Split Osteotomy(BSSO) or Extra Oral Vertical Ramus Osteotomy(EVRO) will improve this gonial angle.

Aim: The aim of this study is to evaluate the change in the Gonial angle following Bilateral Sagittal Split Osteotomy versus Extra Oral Vertical Ramus Osteotomy for Mandibular excess.

Methods: In this prospective study Eight patients with mandibular prognathism were included . That 8 patients (5 male and 3 female) were divided into two groups . In group I, 4 patients with mandibular prognathism were treated by BSSO with rigid fixation and MMF for 4 weeks. In group II, 4 patients with mandibular prognathism were treated by EVRO without rigid fixation and MMF for 6 weeks. Gonial angle is measured for all 8 patients in group I and group II , both pre operatively and post operatively using lateral cephalogram.

Results: In present study the decrease in gonial angle was observed following mandibular setback surgery by BSSO and EVRO.The average decrease in gonial angle in the first group(BSSO) was 4.7 degree and in second group(EVRO) was 7 degree .

Conclusion: By this study we conclude that in patients with increased gonial angle it is better to use EVRO technique as decrease in gonial angle was more that results in better esthetic face , better occlusion, less incidence of inferior alveolar nerve injury and inconspicuous scar. The mandibular setback by BSSRO also give a better esthetic and occlusion, but it may results in increased incidence of neurosensory disturbence and unfavourable split.Thus surgical technique for mandibular prognathism whether BSSRO or EVRO is always depend on surgeons preference and other individual factors.

Key words:- GONIAL ANGLE,BSSO,EVRO

INTRODUCTION

"As yet a child nor yet a fool to fame

I lisped in numbers for the numbers came"

- Alexander Pope

Introduction

Trauma is an unexpected occurrence that leads to a series of events that can be physically and mentally disabling to an individual.

The major causes of facial trauma are road traffic accidents and the rest contributed by other causes like interpersonal violence, falls and sports related injuries. The incidence of facial trauma associated with road traffic accidents is 19.93%[1]. Stringent practices of road safety measures and improved driving conditions have considerably reduced the impact on facial trauma in the western countries and should be the primary goal in our country also.

Trauma to the facial skeleton can be divided into fractures involving the upper one third of the face, the mid face and fractures involving the mandible. The mandible is the only movable bone in the facial skeleton which works in harmony with the skull through the temporomandibular joint. The temporomandibular joint constitutes the condyle, the glenoid fossa and the interarticular disc. An individual is able to perform mastication and other physiologic movements due to the rotational, translational and lateral movements of the condyle which is carefully monitored by a form of 'servo feedback' mechanism mediated by arthrokinetic reflex muscular activity so as to ensure a controlled and stable pattern of mandibular movement. The joint is also necessary for maintaining the vertical dimension of the face and symmetry.

Trauma to the mandible due to various mechanisms can lead to fracture of the articulating part of the mandible that is the condyle. Fracture of mandibular condyle is the commonest site and accounts for 8-50%[2] of all mandibular fractures reported in literature. The condylar fracture occurs most commonly at the neck which is the weakest part. This is a protective mechanism by nature to protect the intracranial contents. The condylar neck acts as a safety valve that prevents the forces of trauma directed at the mandible from reaching the cranial base.

Successful management of condylar fractures is a prime requisite when treating pan facial trauma. The uniqueness of the joint is that with mild to moderate deviation or displacement due to fracture, the joint tends to remodel into a functionally satisfactory working joint without any surgical intervention. This resulted in the evolution of three primary schools of treatment, conservative, relying on rest and immobilisation, functional, where the accent is on active movement as an aid to restitution and surgical, where anatomic reduction is the objective.

The concept of functional treatment approach pioneered by Delaire and closed treatment by intermaxillary fixation was employed for treating condylar fractures because it resulted in a satisfactory functioning masticatory system. Hence most condyle fractures were primarily treated by closed treatment before the introduction of internal fixation devices. The joint is adapted by functional remodelling of the glenoid fossa, condyle, dentition and neuromuscular adaptation. Hence, this mode of treatment was accepted by most as being an effective method to manage condylar fracture. However, minor aesthetic problems like facial asymmetry due to shortening of ramus and a few functional problems like deviation of the jaw on mouth opening, restricted mobility of the joint and malocclusion were associated with this form of management.

In 1983, Zide and Kent[3] proposed the absolute and relative indications for open reduction and internal fixation.

Absolute indications

- Fracture displaced into middle cranial fossa.
- Inability to obtain adequate occlusion by closed reduction.
- Lateral extracapsular displacement.
- Invasion by foreign body.

Relative indications

- Bilateral condyle fractures in edentulous patients.
- Unilateral or bilateral fractures where intermaxillary fixation is not indicated for medical reasons.
- Bilateral condylar fracture associated with midface fracture.
- Bilateral condylar fracture associated with gnathologic problems.

These absolute indications of Zide and Kent are rare in a clinical setting. However, these indications have expanded because of the extensive literature suggesting better results with open reduction and internal fixation. The ability of the surgeon to provide an informed consent to the patient regarding the least morbidity associated with open treatment has also led to further application of open reduction and internal fixation. In current practice, fractures with a deviation of more than 10 degrees, or a shortening of the ascending ramus of more than 2mm, should be treated with open reduction and fixation, irrespective of the level of fracture[4].

The advent of open reduction and internal fixation has dramatically changed the outlook in the treatment of facial fractures. Open reduction and internal fixation of all

fractures including condylar fractures, has the advantage of early mobilisation of the joint, avoids intermaxillary fixation and prevent malocclusions because the segments are reduced and fixed under direct vision which provide good surface bony contact and hence a more predictable healing.

Open reduction and internal fixation of condylar fractures has the advantages of direct anatomic reduction thereby producing good functional results, except that it was fraught with danger of injuring the most important anatomic structure on the face, the facial nerve which is the motor supply to the muscles of facial expression. Damage to this nerve is unacceptable and is considered disastrous in the young and elderly because of the irreversible facial asymmetry. Other complications associated with open reduction are the extra oral scar, salivary fistula due to failure to close the parotid capsule in a watertight fashion and sometimes fracture of the osteosynthetic plate.

Closed reduction of condylar fractures has its own disadvantages like limited mouth opening, limited lateral excursions and protrusion due to lack of translating movement of the fractured condyle, malocclusion, temporomandibular joint pain, loss of vertical dimension of ramus, deviation of the jaw on mouth opening and osteoarthritic changes. With an array of complications associated with closed reduction and in today's setting where prolonged intermaxillary fixation, delay to work, inability to integrate with normal activity can never be tolerated, coupled with loss of function of TMJ has led surgeons to perform open reduction and internal fixation of condylar fractures more frequently and successfully.

Hence, the controversy as to whether to treat the condylar fracture by closed or open treatment has been a bone of contention over the last 60yrs. Condylar fractures, though not uncommon, have been an enigma for the treating surgeons because of the fact that treatment of condylar fractures has been a matter of controversy over the past six decades.

The advent of excellent biocompatible internal fixation devices and the armamentarium along with the surgical skills of the operating surgeon have made open reduction and internal fixation of condylar fracture more feasible with low incidence of facial nerve paresis, which have mainly been a temporary neuropraxia due to excessive retraction and hence transient. Recovery of this transient weakness usually occurs in two weeks.

Open reduction and internal fixation of condylar fractures done successfully restores the patient to their pre-trauma occlusion and function with the added advantage of early function. The advent of endoscopic assisted intra oral approach has further shifted the treatment in favour of open reduction and internal fixation.

Whatever the choice of treatment, Walker[5] enumerated the ideal requirements of successful treatment outcomes

- Restoration of the preinjury occlusion.
- Restoration of normal mouth opening in excess of 40mm.
- Pain free mouth opening.
- Full range of mandibular excursions.
- Restoration of facial and mandibular symmetry.

As open reduction and internal fixation for condylar fractures began to be used more frequently, the choice of an approach that provided best access to the fracture site for reduction and fixation, at the same time producing least morbidity to the facial nerve, had to be identified. Surgical treatment must follow the biomechanical principles and be in accordance with the principal stress trajectory during rigid internal fixation. Therefore, the

surgical approach should ensure good visualisation and allow the surgeon to perform accurate rigid internal fixation.

The literature favours four main cutaneous approaches to the mandibular condyle:

- The incisions below and behind the angle of the mandible- submandibular, retromandibular and rhitidectomy modification. Through a retromandibular incision, the condyle can be approached by a transparotid, anteroparotid and a retroparotid approach.
- The preauricular or postauricular approach.
- The intra oral approach with endoscopic assistance.
- Coronal approach when indicated.

Surgical approaches to the mandibular condyle are fixation technique dependent. For instance, the submandibular approach is very useful when a lag screw is used for low subcondylar fractures but placement of bone plate by this approach is difficult. The pre-auricular approach is advocated for condylar head fractures. The retromandibular approach is the most favoured approach due to its inherent advantages.

Numerous modifications of these approaches to the condyle have been described in the literature with its own merits and demerits. The choice of the approach is individually tailored depending on the location of fracture on the condyle and also surgeon's comfort with a particular approach. Clinical judgement and nerve stimulation can act as an aid in realising the proximity of the nerve during dissection to approach the site.

Of the various approaches of the condyle, the transparotid approach through a retromandibular incision has been the most efficient of the approaches because of the proximity of the incision to the site of fracture and literature suggesting least morbidity of the

facial nerve compared to other approaches and also the ability for perpendicular placement of fixation[6]. This approach is performed through a retromandibular incision, through the facial planes into the parenchyma of the parotid gland. The window between the marginal mandibular branch and the lower buccal branch, or the access between the temporozygomatic and the buccocervical branch can be used for providing excellent access to the fracture site.

The current literature supports the use of open reduction and internal fixation to produce better functional and radiologic results compared to closed reduction but not many studies have assessed the advantages and morbidity of individual approaches to the condyle.

The purpose of this study is to evaluate the result of various clinical parameters like facial nerve weakness, mandibular movement in all directions, maximum mouth opening, incidence of salivary fistula, pain on function, permanent deflection of lower jaw, fracture of osteosynthetic plate, scar length and wound infection after open reduction and internal fixation by a retromandibular transparotid approach.

AIM

Aim

The aim of the study is to clinically follow up patients treated for condylar fractures by open reduction and internal fixation by a transparotid approach.

OBJECTIVES

Objectives

The objectives of the study is to evaluate the functional results and morbidity of the trans-parotid approach on the following

1. Facial nerve weakness
2. Maximum mouth opening
3. Mandibular movement in all directions
4. Pain on function
5. Permanent deflection of lower jaw
6. Fracture of osteosynthetic plate
7. Salivary fistula
8. Scar length
9. Wound infection

REVIEW OF LITERATURE

Review of literature

The first document with regard to treatment of fractures of the lower jaw was the book by Edwin Smith Papyrus from about 3000 BC. Papyrus recommended lacing through a chin bandage and immobilization as the treatment.

Similar treatment methods as that of Papyrus are mentioned in the Arabic records of Albucasis (1778) as well as in the Hippocrates medicine, where a leather frill was wrapped around the head. This is still called as "Funda Hippocrates."

SCHIFF[7] (1910) in his text book, reported mandibular fractures as a rare phenomenon. According to him, the preferred treatment for mandibular fracture was a chin bandage. He also mentioned the importance of surgical management of condylar fracture using wire ligatures besides conservative treatment.

SILVERMAN SL[8] (1925) He was the first to treat displaced condylar fractures through an intra oral approach.

STEINHARDT[9] (1935) advocated conservative treatment for condylar fractures and pointed out the influence of function with regard to the development and morphology of temporomandibular joint.

REICHENBACK[10] (1934) used orthopaedic devices for functional treatment of condylar fractures. He used an activator which produced an intermittent stimulus to the masticatory muscles thus inducing tissue change and avoiding restricted movement of the lateral pterygoid muscles.

THOMA KH[11] (1945) advocated open reduction and treated 32 dislocated fractures of the mandibular condyle. He suggested open reduction because of the various functional

disturbances like limited mouth opening, pain, deviation and restricted excursive movements that were reported after conservative treatment.

DAVIS BA[12] (1956) in his anatomic study on 350 cervicofacial halves, indentified six main types of facial nerve branching patterns. The variations described were no anastomoses between five branches to multiple vertical anastomotic connections. The buccal branch can arise from either the upper division or the lower division of the nerve. This can give off vertical anastomotic branches to the temporozygomatic branch or the cervicofacial branch. The division of the main trunk into temporofacial and cervicofacial divisions may occur within the stylomastoid foramen.

DINGMAN RO AND GRABB WC[13] (1962) based on their study on 100 facial halves, reported that 81% of the rami of marginal mandibular nerve passed above the inferior border of the mandible and the remaining passed in an arc with its lowest point 1cm below the lower border of the mandible. Hence, incisions two finger breadth below the inferior border of the mandible was suggested to prevent injury to the marginal mandibular nerve.

HINDS AND GIROTTI[14] (1967) described the classic retromandibular approach to the TMJ after 10 yrs of experience with 500 cases of vertical subcondylar osteotomy. They approached the TMJ from behind the parotid (retro-parotid) for treatment of mandibular deformities and TMJ related procedures.

MACLENNAN[15] (1969) proposed a classification of condyle fractures using which he discussed the methods for diagnosis and their treatment. According to his study, after a condylar fracture, a satisfactory prognosis was seen in a young patient. However, damage to the articular surface seen in intracapsular fractures of the condylar head produced

secondary deformities. He suggested open reduction for treating grossly displaced extracapsular fractures of condyle and in bilateral condylar fractures so as to maintain the vertical ramus height.

IVY RH[16] (1970) described the post auricular approach to condylar fracture. This approach requires an arc-shaped incision behind the ear. This choice may be especially useful in individuals, often young patients, who do not have a well-demarcated preauricular skin fold. This further hides the incision and helps to protect the auriculotemporal nerve.

SPIESSEL AND SCHROLL[17] (1972) classified condyle fractures into six types based on the level of fracture and their degree of deviation and dislocation. This classification has been found to be very reliable and useful for communication. This is currently widely used for diagnosis and various research purposes.

PETERS RA[18] (1976) used a Risdon incision to expose the fracture site and a stab incision in the preauricular region. Through the stab incision, he introduced a Tennessee drill guide or a bone screw to place drill holes, threading the transosseous wires and repositioning the condyle within the fossa.

LARS LINDHAL[19] (1977) classified condylar fractures comprehensively based on the fracture level, dislocation at the fracture level and relation of condylar head to glenoid fossa.

MAXIME CHAMPY et al[20] (1978) described the modified Michelet technique of mandibular osteosynthesis which consists of monocortical juxta alveolar and subapical osteosynthesis without compression and without intermaxillary fixation. According to

him, this technique can be used in many types of mandibular fracture except in cases of condylar neck fracture and in the presence of preexisting infection.

KOBERG WR AND MOMMA W[21] (1978) Modified the classic retromandibular approach by approaching the condyle through the parotid (transparotid) for treatment of condylar fractures. They used miniaturized dynamic compression plates for a functionally stable osteosynthesis.

ALKAYAT A AND BRAMLEY P[22] (1980) proposed a modified pre-auricular approach to the TMJ and malar arch based on their anatomical dissections of 56 facial halves. They made observations on the relationship of the bifurcation of the main trunk of facial nerve and its temporal branch to bony landmarks. They emphasized the safety of approaching the malar arch through the pocket formed by splitting the lower part of the temporal fascia, thereby providing safe dissection.

ZIDE AND KENT[3] (1983) enumerated the absolute and relative indications for treatment of condylar fractures and also described the face lift approach for treating condylar fractures. They suggested that, the need for open reduction is greater in a post pubertal patient due to lack of functional remodeling of the condyle.

EDWARD ELLIS III et al[23] (1985) analyzed 2,137 cases of mandibular fractures of which condyle fractures composed of 29.3%. The most common cause in his study were assaults, followed by falls and motor vehicle accidents. Males were more commonly affected and the peak age of occurrence was 20-30yrs.

ROWE AND WILLIAMS[24] (1986) in their text book have described the evolution and principles of treatment of condylar fractures. The pattern of mandibular growth and the

morphology of the adult and the paediatric condyle leading to the difference in the fracture pattern have been explained.

KITAYAMA et al[25] (1989) described a new method of intraoral open reduction of condyle fractures using a screw applied through the mandibular crest. Based on a study on 50 mandibles, they defined mandibular crest as the protuberance between the retromolar trigone and the condylar process. It was also the thickest portion of the ascending ramus available for osteosynthesis.

HABEL G[26] (1990) advocated the intraoral trans-coronoidal approach for treating fractures of the condylar neck, to circumvent the high morbidity associated with facial nerve injury and a visible scar due to the use of extra-oral approaches.

KIRK L FRIDRICH et al[27] (1992) evaluated the incidence of condyle fracture in a total of 1,067 cases of mandibular fractures. Condylar fractures accounted for 26% of the fractures. The condyle region was the most commonly fractured, where automobile accidents were the cause of trauma.

UPRO SILVENNOINEN[28] (1992) analyzed 382 patients with condyle fractures over a 3 year period and described different patterns of condyle fractures. Falls and road traffic accidents resulted in severe fractures in which condyle was dislocated out of the glenoid fossa. Violence showed an uniform type characterized by subcondylar location and no displacement or deviation at fracture line. 56.15% of fractures in their study were indicated for ORIF.

STARCK W J[29] (1993) proposed a modified endaural approach to the TMJ for surgical treatment of internal derangement and other TMJ disorders. This approach produces a broad based flap with an excellent blood supply. Further, the perichondrium is not

violated, and no cartilage is transected in this approach. Hence, there is no residual cartilaginous deformity.

HAYWARD AND SCOTT[30] (1993) reviewed the literature from 1943-1993 on the various controversies that existed in treating condyle fractures. Controversies with regard to the treatment methods, surgical approaches and modes of fixation are discussed.

EDWARD ELLIS III[31](1993) discussed the advantages and disadvantages of pre-auricular, submandibular, intraoral and retromandibular approaches to the condyle. He also suggested that rigid fixation of condylar fracture was advantageous for the patient as it avoided the need for prolonged intermaxillary fixation and also produced good functional results.

NILS WORSSAE AND JENS J THORN[32] (1994) compared open reduction with closed reduction of unilaterally dislocated low subcondylar fractures in adults to assess the complications associated with it. They concluded that patients treated by closed reduction had a significantly more number of complications such as malocclusion, mandibular asymmetry, impaired masticatory function and pain located in joint or masticatory compared with those treated surgically.

GOSAIN[33] (1995) in his anatomic study, identified that there were more frequent interconnections between the zygomatic and buccal branches (70%) than the interconnections between the marginal mandibular branches and other facial nerve branches (15%).

WIDMARK G et al[34] (1996) compared results of open versus closed reduction of condyle fractures one year after trauma and evaluated TMJ, muscle, joint pain, mouth opening, open bite, overjet, neurologic disturbance. They concluded the results to be not

significantly different from functional point of view but were better in open reduction. The possibility of avoiding IMF is a factor in favor of open reduction.

CYRILLE CHOSSEGROS et al[35] (1996) performed the short retro-mandibular approach to subcondylar fractures with displacement but with no dislocation in 19 patients. The results with this approach were successful. Follow up of their cases showed good mouth opening with symmetric laterotrusive movement and no case of permanent marginal mandibular nerve palsy. They concluded that their approach is an easy and safe technique for displaced subcondylar fractures.

ANASTASSOV GE et al[36] (1997) treated 7 cases of condyle fractures using a new facial rhytidectomy approach. The advantages of this technique were excellent exposure, predictable and safe dissection, inconspicuous scar due to the incorporation of endaural extension and minimal post operative complications.

RAYMOND J FONSECA AND ROBERT V WALKER [2] (1997) in their text book on maxillofacial trauma have given a detailed description on the various etiologies, clinical features and investigations for the diagnosis of condylar fractures. They have also described both closed and open treatment of condylar fractures with their advantages and disadvantages.

MOOS KF et al[37] (1998) discussed the current consensus on the management of condylar fractures after the consensus conference held in Budapest, Hungary. It was concluded that major area of controversy revolved around the indication for open procedure in adult patients. However, most surgeons agreed on closed reduction as the management of choice for paediatric condyle fractures.

TATEYUKI IIZUKA et al[38] (1998) evaluated the long term results of open reduction without fixation for displaced condylar process. He suggested that by this technique, the complications associated with osteosynthesis could be prevented. However, this technique produced a mild deviation of the condyle from the reduced position postoperatively. This form of surgical management enabled satisfactory outcome to be achieved.

CELSO PALMIERI et al[39] (1999) compared mandibular and condylar mobility after open and closed treatment of mandibular condylar fractures. According to them, in fractures treated by closed reduction, the more displaced the fractured condylar process, the more limited was the mobility of the mandible. However, open reduction of severely displaced fractures produced greater condylar mobility. Therefore, they suggested that open reduction produced functional benefits to patients with severely displaced condylar fractures.

GERHARD UNDT et al[40] (1999) treated 55 patients with 57 dislocated condylar neck fractures by a transoral approach using miniplate osteosynthesis. Good functional rehabilitation was achieved with this approach. They suggested this approach especially in situations where visible scars in the head and neck region had to be avoided for cosmetic reasons and in potential keloid formers.

CHOI BH AND YOO JH[41] (1999) performed a prospective study of 34 patients with high condylar neck fractures. They performed open reduction and internal fixation through a pre-auricular incision with exposure of the facial nerve. The clinical and radiological results in 25 patients were assessed. Immediate postoperative radiographs showed excellent reduction in 25 patients and 20% incidence of temporary facial nerve

injury was reported with this approach, three patients had plate fractures or screw loosening and 5 patients had transitory greater auricular nerve hypoesthesia.

KEMPERS KG[42] (1999) reviewed the anatomy of mandibular condyle and the various surgical approaches performed to treat the fractured mandibular condyle. He found that the preauricular, submandibular and intraoral approaches in this order were preferred for treating condylar fractures. He also emphasized the importance of a thorough knowledge of the mandibular anatomy when performing any approach.

EDWARD ELLIS et al[43] (2000) compared the results of open and closed treatment of condylar fractures. The results of their study showed that closed techniques had a significantly greater percentage of malocclusions compared to patients treated by open reduction, in spite of the fact that initial displacement of the fracture was greater in patients treated by open reduction.

EDWARD ELLIS III AND GAYLORD THOCKMORTON[44] (2000) analyzed 146 patients, of which 81 were treated closed and 65 by open methods. Post operative posteroanterior cephalograms were used to assess posterior facial height and bigonial and occlusal planes. Additionally, panaromic radiographs were used to assess ramus height. They concluded that patients treated by closed methods developed asymmetry characterized by shortening of the face on the side of fracture. However, this is a biologic adaptation that helps reestablish a new temporomandibular articulation.

EDWARD ELLIS et al[45] (2000) analyzed a total of 178 patients with unilateral fractures of the condylar process of which 85 were treated by closed method and 93 treated by open method. They concluded that surgical complications that led to permanent

deformity or dysfunctions are uncommon and open treatment of mandibular condyle fractures can be successfully performed.

CHRISTOPHE MEYER et al[46] (2002) performed a photoelastic analysis of bone deformation in the region of the mandibular condyle during mastication and concluded that compression stress pattern were present along the posterior border of the ramus and tensile stress pattern along the anterior border of the ramus in the zone situated below the sigmoid notch. Hence they implied that new concepts are needed for the positioning of osteosynthesis plates in the condylar region close to the tensile stress lines just like the principles followed in other parts of mandible.

DEVLIN MF et al[47] (2002) treated 42 condylar fractures by ORIF using the retromandibular approach and assessed the surgical morbidity associated with the approach. They reported 2 fractures to have been poorly reduced, one patient developed hypertrophic scar and 3 patients had transient facial nerve weakness. They have also emphasized the importance of an informed consent from patients when treating for condylar fractures.

GUERRISSI JO[48] (2002) suggested the advantages of a transparotid transcutaneous approach by means of a transbuccal trocar set. This approach avoided the problems like placement of screws in an oblique direction and retraction of soft tissues and nerve branches which were commonly associated with the submandibular and classic retromandibular approaches.

GREENBERG AND GLICK[49] (2003) in their text book on Oral Medicine, in the chapter on temporomandibular joint disorders, have given the normal range for the various mandibular movements. The mean mouth opening was 52.8mm (38.7-67.2mm)

for men and 48.3mm (36.7-60.4mm) for women. Normal lateral and protrusive movements are ≥ 7mm.

MANISALI M et al[50] (2003) performed a prospective study on 20 patients with condylar neck fractures treated by a transparotid retromandibular approach. Their results showed temporary weakness of facial nerve was seen in 6 (30%) patients, 2 patients had temporary deficit of greater auricular nerve and one developed a sialocele and none of the patients developed any permanent complications. Hence this approach was considered successful.

ROBERT CELIC[51] (2003) described a clinically useful and a simple method for measuring the mandibular movements. The maximal mouth opening was measured at the inter incisal region using a vernier caliper. Excursive movements in protrusion were measured with the patient initially at the physiological rest position from which the patient moved the mandible anterior without tooth contact. The distance from the incisal edge of maxillary central incisor to the incisal edge of mandibular central incisor was measured in this position. The horizontal overlap was also measured and then added to the distance between the upper labial surface and the lower incisal edge. Mediotrusion on the fractured and the non fractured sides were measured with the subject opening the mouth slightly and mandible moved as far to the left or right as possible. Measurement was done with a millimetre ruler from the labioincisal embrasure between the maxillary central incisors to the labioincisal embrasure of the mandibular incisors.

TODD BRANDT M AND RICHARD HAUG[52] (2003) discussed the various indications, implications and treatment results following open and closed treatments. They concluded that open treatment was associated with scar development and paralysis

of facial nerve branches while closed treatment was associated with more of functional problems. They believed that in the future, the endoscopic approach could replace conventional technique, once techniques and instrumentation were refined.

LOUKOTA RA et al[53] (2005) proposed a subclassification for condylar process fractures. They defined the terms diacapitular fracture, fracture of the condylar neck and fracture of the condylar base. They also defined the term minimal displacement as a displacement of less than 10 deg or overlap of the bone ends less than 2mm or both.

EDWARD ELLIS III and GAYLORD THOCKMORTON[54] (2005) have reasoned as to why different treatment options in treating condylar fractures have all produced satisfactory outcomes and concluded that the biologic adaptations must occur in the condyle and glenoid fossa to provide the patient with satisfactory outcome regardless of how the fractures were treated.

ALES VESNAVER[55] (2005) determined the safety and efficiency of periauricular transparotid approach for ORIF after treating 36 condylar fractures. Their study showed that 8 cases that is 22% of their patients had transient facial nerve weakness and 5 patients developed salivary fistula. They emphasized the importance of closing the parotid capsule in a watertight fashion. As 94% of the patients were satisfied with the outcome of treatment, the approach was concluded to be safe and effective.

UWE ECKLET et al[56] (2006) performed a prospective randomized multicentric study on open versus closed treatments of fracture of the mandibular process. All fractures were displaced, being either angulated between 10 degrees and 45 degrees and the ascending ramus was shortened by 2mm. Their follow up concluded that both treatment options

yielded acceptable results. However, the functional results were found to be in favour of open reduction.

SCHOEN R et al[57] (2008) performed endoscopic assisted transoral open reduction and internal fixation of 26 displaced bilateral condylar fractures and achieved early rehabilitation with this approach. No complications involving the facial nerve that are involved using percutaneous approach were involved in their study. They termed this approach as a minimally invasive approach because facial nerve injury and visible scars were avoided.

OLIVER TROST et al[58] (2008) described a high cervical transmassetric anteroparotid approach for ORIF of condylar fracture. This approach reduced surgical complications like salivary fistula, facial nerve injury. The choice of fixation was a trapezoidal plate (TCP) which is based on the Meyer's photoelastic analysis of the stress pattern on the condyle.

NARAYANAN V et al[6] (2008) treated 35 displaced condylar fractures, of which 8 were bilateral and 23 were unilateral fractures, by a retromandibular transparotid approach. They reported good functional and occlusal results with this approach. They reported only 3% incidence of temporary facial nerve weakness. They concluded retromandibular transparotid approach to be a safe and effective method for condylar fractures.

GIOVANNI GERBINOT et al[59] (2009) retrospectively evaluated the surgical management of 57 condylar fractures of 50 patients from a total of 204 patients treated by various surgical approaches. The various approaches used were retromandibular (48%), pre-auricular (22%), submandibular (14%) and combined approach (16%). They reported 12% of their patients with temporary weakness of facial nerve and 4% had mild facial

nerve palsy. They concluded that surgical treatment in association with postoperative physiotherapy promotes early recovery to function with few complications.

OLIVER TROST et al[60] (2009) treated 35 patients with 38 low subcondylar fractures with modus TCP (trapezoidal plate) plates using a high cervical transmassetric approach. They reported favorable functional and radiologic results with this approach. Their results showed a mean mouth opening of up to 40mm, mean lateral movement of 11mm and mean protrusion of 12mm were achieved. No cases of facial palsy occurred and hence the approach was considered safe and reproducible producing excellent results.

DOWNIE JJ et al[61] (2009) performed a prospective study on 51 condylar fractures in 50 patients to assess the morbidity associated with open reduction and internal fixation by a transparotid approach. The condyle was approached between the buccal and zygomatic branches of the facial nerve. Only 7 cases (14%) with temporary weakness of facial nerve were reported and good functional results were achieved.

BIGLIOLI F et al[62] (2009) treated 38 condylar fractures using a trans- massetric approach through a 20mm mini retromandibular incision. They reported good esthetic results due to the use of a very small incision and no cases of facial nerve injury. They suggested that their approach allowed treatment of condylar fractures at any level in a simplified and rapid manner.

JAN KLATT et al[63] (2010) analyzed 48 patients with fractured condylar process treated surgically using a transparotid approach over a two year period. Their results showed an average inter-incisal distance of 42.37mm, protrusion averaged 7.14mm, mediotrusion on fractured side averaged 8.22mm and that of non-fractured side averaged 10.12mm. 10% of the patients had temporary atony of the facial nerve and no patients developed

permanent atony. Hence, it was concluded that this approach was most appropriate for class II fractures (Spiessel and Schroll) of condyle.

KHALID ABDEL GALIL et al[4] (2010) reviewed the evidence available in literature for treating fractures of the condylar process. Their review results showed that there was increasing evidence in favor of open treatment when compared with closed treatment. Hence, in current day practice, a fracture with a deviation of 10degrees or a shortening of ascending ramus by 2mm should be treated by ORIF without any complications. However, no trial evidence existed that compared the effectiveness of the various approaches described for access to the ramus condyle region.

ALES VESNAVER et al[64] (2012) treated 42 condyle fractures surgically with a transparotid approach and compared it with 20 conservatively treated patients. The most important complication was temporary paresis of facial nerve branches which occurred in 24% of the cases. Plate fracture occurred in 12%, only when plates used for fixation were less than 2.0mm. Hence, surgical treatment with a transparotid approach was considered safe surgical technique.

YANG L et al[65] (2012) treated 42 patients with 48 subcondylar fractures using a retromandibular transparotid approach and prospectively evaluated the stability of a single 2mm miniplate fixation for such fractures. They reported a mean inter incisal opening of 44mm, 8 cases (18%) with transient injury to the facial nerve branches and 3 cases (8%) with salivary fistula and no cases of greater auricular nerve anaesthesia/paresthesia were reported. A single 2mm mini plate was found to be providing stable results. They concluded that this approach provided good access with low morbidity and good cosmetic results.

RICCARDO GIRITTO et al[66] (2012) treated 19 patients, which included 8 high subcondylar and 11 condylar base fractures using a retromandibular transparotid approach. Their results showed only 2 patients to have a transient marginal mandibular nerve palsy, which resolved in 1-2 weeks. Hence, this approach was concluded to be safe and a time sparing alternative to the intraoral endoscopic approach.

KIM BK et al[67] (2012) treated 28 patients with condylar neck and subcondylar fractures through retromandibular transparotid approach and reported excellent results. The advantages of this approach are short access route, easy reduction, short operating time, stable postoperative occlusion. There was also no permanent facial nerve injury, salivary leakage, or preauricular hypoesthesia. Hence, this approach is considered to be safe and effective in treating condylar neck and subcondylar fractures.

COLLETTI G et al[68] (2012) used the mini retromandibular access to treat condyle fractures which were associated with pan facial fractures in six patients. The importance of treating extracapsular condylar fractures by open reduction and internal fixation to restore the vertical and saggital dimension of the mandible, thereby restoring the facial height has been described. The bone morphology restoration after treatment was good with the approach. No complications and no facial nerve lesions were observed. The approach also resulted in an inconspicuous scar.

SURGICAL ANATOMY

SURGICAL ANATOMY

Condyle

The condyle is the portion of the mandible that articulates with the cranium around which movement occurs. From the anterior view, it has medial and lateral projections called poles (Figure 1). The medial pole is generally more prominent than the lateral. The condyle seems to be slightly rotated as though an imaginary line drawn through the lateral and medial poles would extend medially and posteriorly towards the anterior border of the foramen magnum. The total mediolateral length of the condyle is between 18 and 23mm and the anteroposterior width is between 8 and 10mm. The actual articulating surface of the condyle extends both anteriorly and posteriorly to the most superior aspect of the condyle. The posterior articulating surface is greater than the anterior surface. The articulating surface of condyle is quite convex anteroposteriorly and slightly convex mediolaterally. Anatomically, the condyle is divided into head, neck and subcondylar region. The region of maximum constriction in the condyle is the condylar neck and the portion above the constriction constitutes the head and below it is the subcondylar region. The anterior surface of the neck of the condyle is hollowed out to form a depression or pit which gives attachment to the lateral pterygoid muscle. The lateral pterygoid is the main protrusive and opening muscle of the mandible. It is arranged in parallel fibred units unlike other muscles which are multipennated. This arrangement allows greater displacement and velocity in the lateral pterygoid. The condyle is buttressed laterally by the capsule formed by the lateral ligament of the TMJ thereby preventing lateral displacement of the condyle during trauma.

Figure 1* **Condyle- anterior and posterior view**

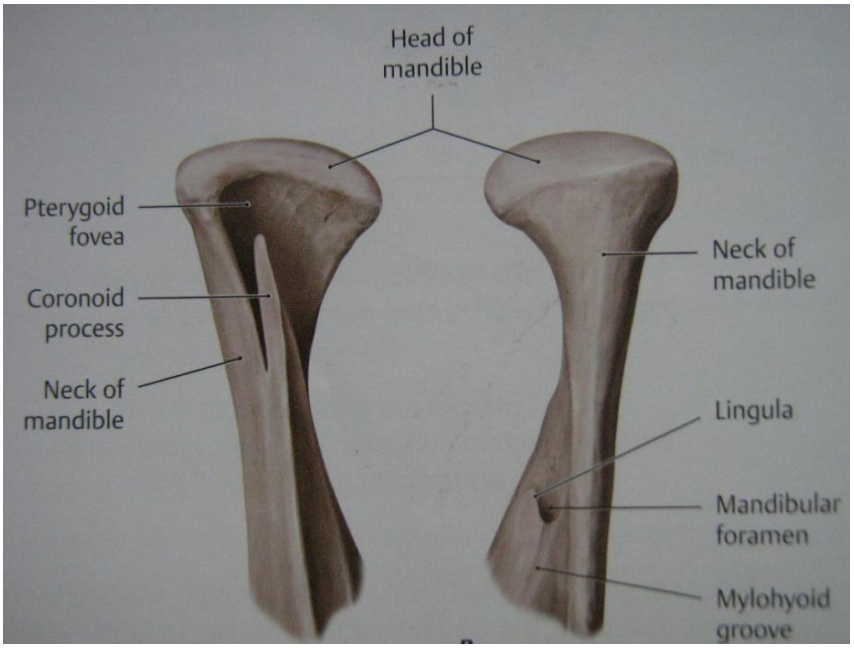
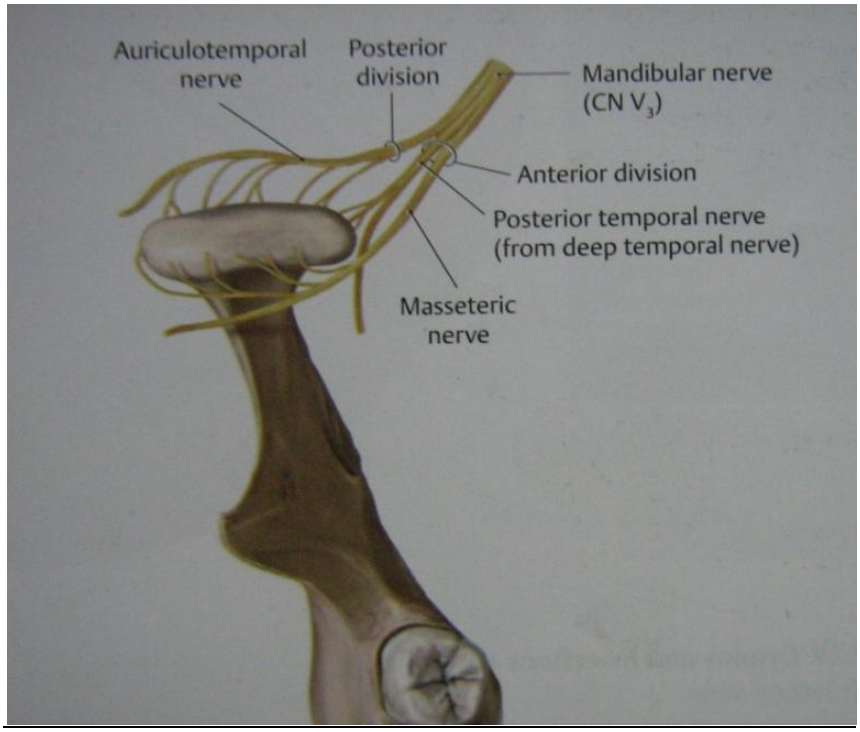


Figure 2* **Nerve supply to the condyle**



*ERIC BAKER[69]- Head and neck anatomy for dental medicine.

Age changes of Condyle

Until the age of two years, the condylar head is richly vascular, penetrated on the articular surface by numerous blood vessels. After two years, these vessels diminish although the condylar head remains vascular. The cortical head is broader and fuller, and the neck is thicker than in the mature version. The glenoid fossa is shallower than in the adult and has a more concave appearance with steeper and more pronounced articular eminence. The bone quality is softer in the child. As the individual progresses into adolescence and adulthood, the condyle becomes less vascular, bone becomes less pliable and the condyle assumes the adult configuration. The increased vascularity combined with the thin cortical bone makes the child condyle more susceptible to "burst" type of fractures.

Vascular supply and Innervation

The vascular supply of the condyle is mostly derived from 3 sources. A branch of the inferior alveolar artery courses upwards towards the neck of the condylar process, where it anastomoses liberally with vessels from the attached musculature. Another major component to the condyle and the articular surface is derived from the TMJ capsule with its lush vascular plexus. There are also large contributions from branches of the lateral pterygoid muscle through its attachment at the pterygoid fovea. There is a rich plexus of veins in the posterior aspect of the joint associated with the retrodiskal tissues, which alternately fill and empty with protrusive and retrusive movements, respectively, of the condyle disk complex and which also functions in the production of synovial fluid.

The nerve supply to the TMJ is predominantly from branches of the auriculotemporal nerve with anterior contributions from the masseteric nerve and the posterior deep temporal nerve (Figure 2). Many of the nerves to the joint appear to be vasomotor and vasosensory, and they may have a role in the production of synovial fluid.

Parotid gland

The parotid gland is the largest of the major salivary glands. It is a large, irregular, lobulated gland which extends from the zygomatic arch to the upper part of the neck, where it overlaps the posterior belly of digastric and the anterior border of sternocleidomastoid. It extends forward over the posterior half of masseter muscle. It also extends behind the ramus of the mandible and medially to a variable distance extending to the lateral pharyngeal space. It is enclosed by the deep cervical fascia which splits to enclose the gland forming the parotid capsule. Facial nerve enters the gland through the posteromedial surface.

Facial Nerve

The main trunk of the facial nerve emerges from the skull base at the stylomastoid foramen. It lies medial, deep, and slightly anterior to the middle of the mastoid process at the lower end of the tympanomastoid fissure. After giving off the posterior auricular, it branches to the posterior belly of digastric and stylomastoid muscles. It then passes obliquely, inferiorly and laterally into the substance of the parotid gland. The length of the facial nerve trunk that is visible to the surgeon is about 1.3cm. It divides into the temporofacial and cervicofacial divisions at a point inferior to the lowest part of the bony external auditory meatus (Figure 3). The average distance from the lowest point on the external bony auditory meatus to the bifurcation of the facial nerve is 2.3cm. Posterior to the parotid gland, the nerve trunk is at least 2cm deep to the surface of the skin. The two divisions proceed forward in the substance of the parotid gland and divide into their terminal branches.

The marginal mandibular branch courses obliquely downward and anteriorly. It frequently arises from the main trunk well behind the posterior border of the mandible and crosses the posterior border in the lower one third of the ramus. This positioning leaves a

void between the buccal branches and the marginal mandibular branch or branches through which the mandible can be approached safely.

Retromandibular Vein

The retromandibular vein is formed in the upper portion of the parotid gland, deep to the neck of the mandible, by the confluence of the superficial temporal vein and the maxillary vein. Descending just posterior to the ramus of the mandible through the parotid gland, or folded into its deep aspect, the vein is lateral to the external carotid artery. Both vessels are crossed by the facial nerve. Near the apex of the parotid gland, the retromandibular vein gives off an anteriorly descending communication that joins the facial vein just below the angle of the mandible. The retromandibular vein then inclines backwards and unites with the posterior auricular vein to form the external jugular vein.

Transparotid approach via retromandibular incision

The retromandibular approach exposes the entire ramus from behind the posterior border. It is therefore useful for procedures involving the area on or near the condylar neck/head. The distance from the skin incision to the condyle is also reduced.

TECHNIQUE

The retromandibular approach was described by Hinds and Girrotti[14] and later modified by Koberg and Momma[21]. The incision is placed at the posterior ramus, just below the earlobe. Dissection to the posterior border of the mandible is direct, traversing the parotid gland and exposing some branches of the facial nerve.

Step 1. Preparation and Draping

Pertinent landmarks should be exposed throughout the procedure, keeping the corner of the mouth and lower lip within the surgical field anteriorly and the entire ear posteriorly. These landmarks orient the surgeon to the course of the facial nerve and allow observation of lip motor function.

Step 2. Marking the Incision and Vasoconstriction

The skin is marked before injection of a vasoconstrictor. The incision for the retromandibular approach begins 0.5cm below the lobe of the ear and continues inferiorly 3 to 3.5cm (Figure 4). It is placed just behind the posterior border of the mandible. Local anaesthetic with a vasoconstrictor may be injected subcutaneously to aid haemostasis at the time of incision. One should not inject local anaesthetics deep to the platysma muscle because of the risk of rendering the facial nerve branches nonconductive, making electrical testing impossible.

Step 3. Skin Incision

The initial incision is carried through skin and subcutaneous tissues to the level of the scant platysma muscle present in this area. Undermining the skin with scissor dissection in all directions allows ease of the retraction and facilitates closure. Haemostasis is then achieved with electrocoagulation of bleeding sub-dermal vessels.

Step 4. Dissection through parotid gland

After retraction of the skin edges, the scant platysma muscle is sharply incised in the same plane as the skin incision (Figure 5). At this point, the superficial musculoaponeurotic layer (SMAS) and parotid capsule are incised and blunt dissection begins within the gland in an anteromedial direction towards the posterior border of the mandible.

A haemostat is repeatedly inserted and spread open parallel to the anticipated direction of the facial nerve branches (Figure 6). The marginal mandibular branch of the facial nerve is often, but not always, encountered and can be identified by nerve stimulator. If the marginal mandibular branch interferes with exposures, it may be retracted superiorly or inferiorly depending on its location. A useful adjunct in retracting the marginal mandibular branch involves dissecting it free from surrounding tissues proximally for 1 cm and distally

Figure 3* **Terminal branches of facial nerve**

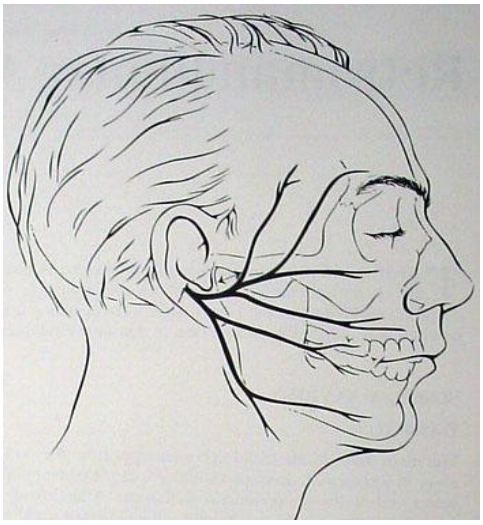


Figure 4* **Skin incision**

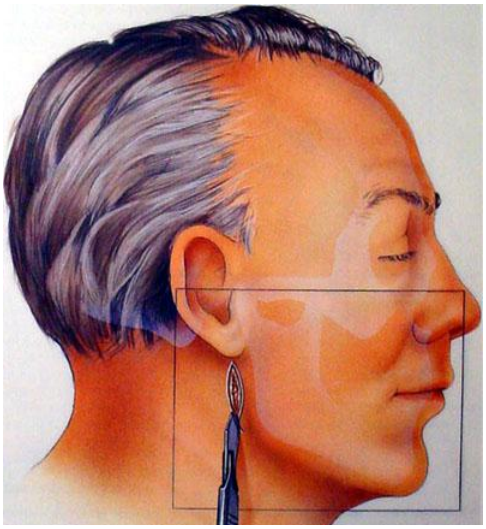
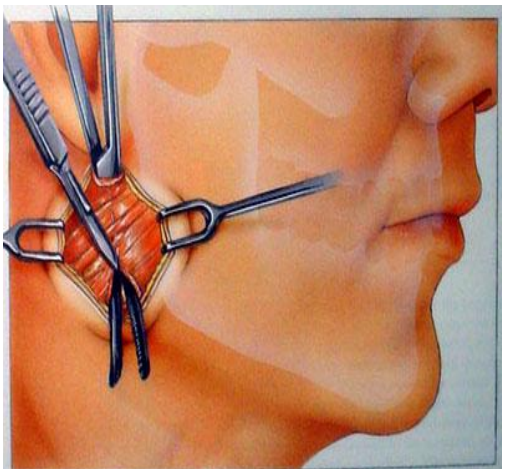


Figure 5* **Platysmal dissection**



*ELLIS and ZIDE[70]- Approaches to the facial skeleton

for 1.5 to 2cm. This simple manoeuvre determines whether the nerve is better retracted superiorly or inferiorly. The window between the marginal mandibular branch and the lower buccal branch or the access between the temporozygomatic and the buccocervical branch can be used. Dissection then continues until the only tissue remaining on the posterior border of the mandible is the periosteum of the pterygomasseteric sling. The retromandibular vein runs vertically in the same plane of dissection and is commonly exposed. This vein rarely requires ligation unless it has been inadvertently transected.

Step 5. Division of the Pterygomasseteric Sling and Submasseteric Dissection

After retraction of the dissected tissues anteriorly, a broad retractor is placed behind the posterior border of the mandible to retract the mandibular tissues medially. The posterior border of the mandible with the overlying pterygomasseteric sling is visualized. The pterygomasseteric sling is sharply incised with a scalpel (Figure 7). An incision in the posterior part of the sling bleeds less and begins as far superiorly as is reachable and extends as far inferiorly around the gonial angle as possible. The sharp end of a periosteal elevator is drawn along the length of the incision to begin stripping the tissues from the posterior border of the ramus. The masseter is stripped from the lateral surface of the mandible using periosteal elevators (Figure 8). Clean dissection is facilitated by stripping the muscle from top to bottom. The entire lateral surface of the mandibular ramus to the level of the temporomandibular joint capsule as well as the coronoid process can be exposed. Retraction of the masseter muscle is facilitated by inserting a suitable retractor into the sigmoid notch.

Step 6. Closure

The masseter and medial pterygoid muscles are sutured together with interrupt resorbable sutures. Closure of the parotid capsule/SMAS and platysma layer is important to avoid salivary fistula. A running, slowly resorbing horizontal mattress suture is used to

Figure 6* **Anteromedial dissection in substance of parotid**

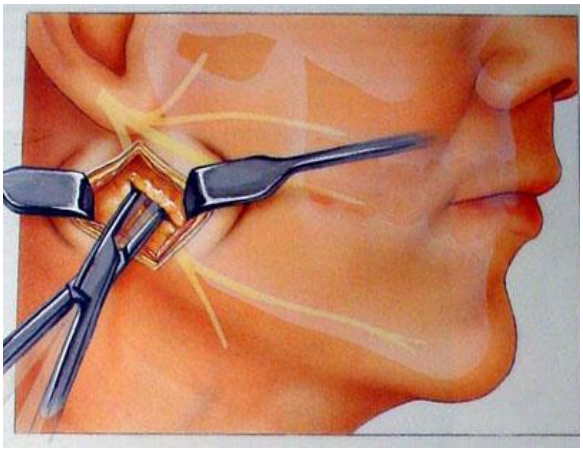


Figure 7* **Division of pterygomassetric sling**

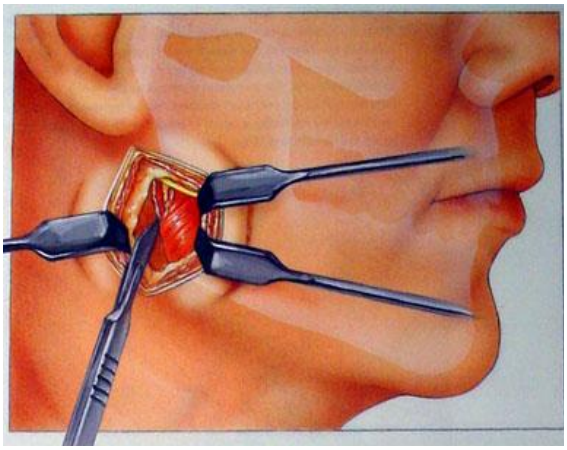
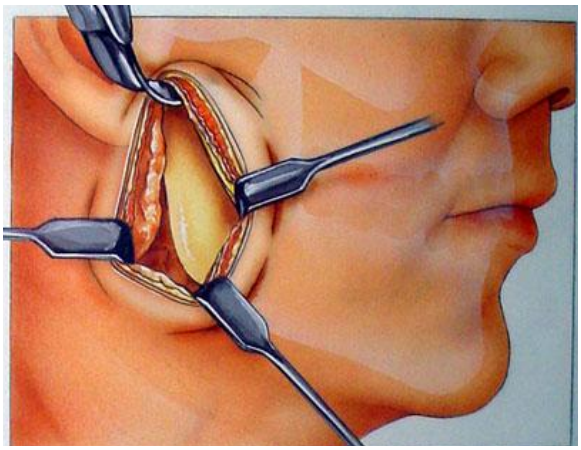


Figure 8* **Exposure of ascending ramus and condyle**



*ELLIS and ZIDE[70] - Approaches to the facial skeleton

close the parotid capsule, SMAS, and platysma muscle in one watertight layer. Placement of subcutaneous sutures is followed by skin closure.

MATERIALS AND METHODS

MATERIALS AND METHODS

This prospective study comprises of 12 patients who reported with condylar fracture to the Department of Oral and Maxillofacial Surgery, Rajas Dental College during the period June 2010-June 2012, who fulfilled the inclusion criteria and subsequently underwent open reduction and internal fixation through a trans-parotid approach. An informed consent (Annexure I) was obtained from all patients prior to surgery.

Inclusion criteria

1. Age above 16 years
2. Unilateral condylar neck or subcondylar fractures with displacement.
3. Other associated fractures isolated to the facial skeleton.

Exclusion criteria

1. Bilateral fractures were excluded as it is much difficult to assess the joint mobility as the contralateral side cannot be used for control.
2. History of occlusal disturbances or skeletal malocclusions.
3. History of pathology of temporomandibular joint.

Characteristics of Fractures in our study

Table a Location of fracture

Condylar neck	9
Subcondylar	3
Condylar Head	0

Table b Distribution of fracture according to Spiessel and Schroll classification

Fracture		Case distribution
Type I	Condylar fracture without angulation or dislocation	0
Type II	Low condylar fracture with angulation	0
Type III	High condylar fracture with angulation	0
Type IV	Low condylar fracture with dislocation	12
Type V	High condylar fracture with dislocation	0
Type VI	Head fracture	0

Table c Associated mandibular fracture

Symphysis	2
Parapymphysis	6
Body of mandible	2
Angle	2

Table d Other associated facial fractures

Zygoma	0
Maxilla	1
Dento alveolar	3

Table e Direction of displacement of condylar fragment

Antero Medial	10
Lateral	2

Comprehensive case histories were taken for all the patients using a case proforma (Annexure II). Preoperative clinical pictures of the patients (Figure 9a) and of their occlusion (Figure 9b) were taken. Pre operative investigations included an Orthopantamogram (Figure 9c), CT scan (Figure 9d), routine blood investigations, electrocardiogram and chest radiograph.

Surgical Procedure

- All 12 patients underwent general anaesthesia with nasotracheal intubation.
- Armamentarium was setup (Figure 10) and skin preparation with betadine solution was done and draped.
- A retromandibular incision 3-3.5cm was made parallel to the posterior border of the mandible starting 0.5cm below ear lobe (Figure 11a).
- Dissection through the skin, subcutaneous tissue and platysma was done.
- Parotid capsule was identified and incised sharply (Figure 11b). Blunt dissection was done through the parotid along the anticipated direction of facial nerve branches.
- Masseter muscle was indentified beneath the parotid gland and pterygomassetric sling was incised.
- Subperiosteal dissection along the posterior border of the mandible was done to reach the fracture site.
- Distraction of the body of the mandible downwards intraorally was done by an assistant to aid visibility and subsequent reduction of the condylar fragment when medially displaced.
- Open reduction (Figure 11c) and internal fixation (Figure 11d) of condyle fracture was done with one 2.0mm four hole with gap stainless steel mini plates and 2mm×6mm stainless steel screws.

- ORIF of the associated mandibular fracture (Figure 11e) was performed after achieving intermaxillary fixation.
- Postoperative intermaxillary fixation was not done in patients with stable occlusion. However if found to be unstable, intermaxillary elastics were placed for five days to guide the patient to his pre injury occlusion.
- Closure of parotid capsule with three zero vicryl suture was done in a watertight fashion. Subcutaneous layer was closed with three zero vicryl sutures.
- Skin incision was closed with four zero Prolene interrupted sutures (Figure 11f).
- Intensive functional therapy was begun after the first postoperative week. Soft diet was advised for 4 weeks.

Suture removal was done on the seventh post-operative day. Orthopantamograms (Figure 12a), clinical photographs of the patient (Figure 12b) and of the occlusion (Figure 12c) were taken postoperatively. The postoperative follow up examinations were performed at 2 weeks, 6 weeks, 3 months, 6 months and evaluated the following parameters using the patient data form (Annexure III).

1. Facial nerve weakness based on House-Brackmann scale.
2. Maximum mouth opening.
3. Mandibular movement in all directions.
4. Pain on function.
5. Permanent deflection of lower jaw.
6. Fracture of osteosynthetic plate.
7. Salivary fistula.
8. Scar length.
9. Wound infection.

Inconspicuous scar was seen postoperatively (Figure 13a) and the scar length was measured with a metal ruler. Maximal mouth opening (Figure 13b) was measured at the inter-incisal region using a vernier caliper (Figure 13c).

Excursive movements (Figure 14) in protrusion were measured with the method described by Celic[51]. The patient was initially at the physiological rest position from which the patient moved the mandible anterior without tooth contact. The distance from the incisal edge of maxillary central incisor to the incisal edge of mandibular central incisor was measured in this position. The horizontal overlap was also measured and then added to the distance between the upper labial surface and the lower incisal edge. Mediotrusion on the fractured and the non-fractured sides were measured with the subject opening the mouth slightly and mandible moved as far to the left or right as possible. Measurement was done with a millimetre ruler from the labioincisal embrasure between the maxillary central incisors to the labioincisal embrasure of the mandibular incisors.

Occlusion was evaluated with the assistance of an orthodontist.

The muscles of facial expression were evaluated for weakness (Figure 15) and scored, based on House-Brackman scale[71] (Annexure IV).

Pain on function was measured using the numeric visual analog scale[49] (Annexure V) with the most severe pain indicating a score of 10 and no pain indicating a score of 0.

Permanent deflection of the jaw on mouth opening was evaluated objectively.

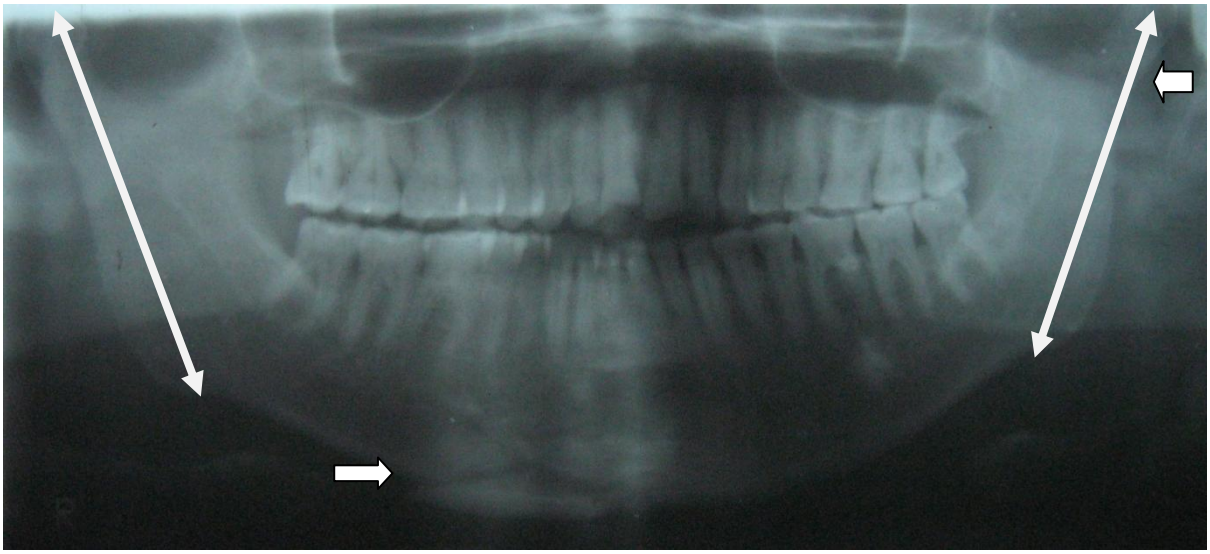
CLINICAL PICTURES

FIGURE 9 PRE-OPERATIVE

(a)Trauma to the chin

(b)Deranged occlusion

(c)OPG showing fractures of the left condylar process and communited right mandibular parasymphysis fracture



(d) CT scan showing medial displacement of condylar segment

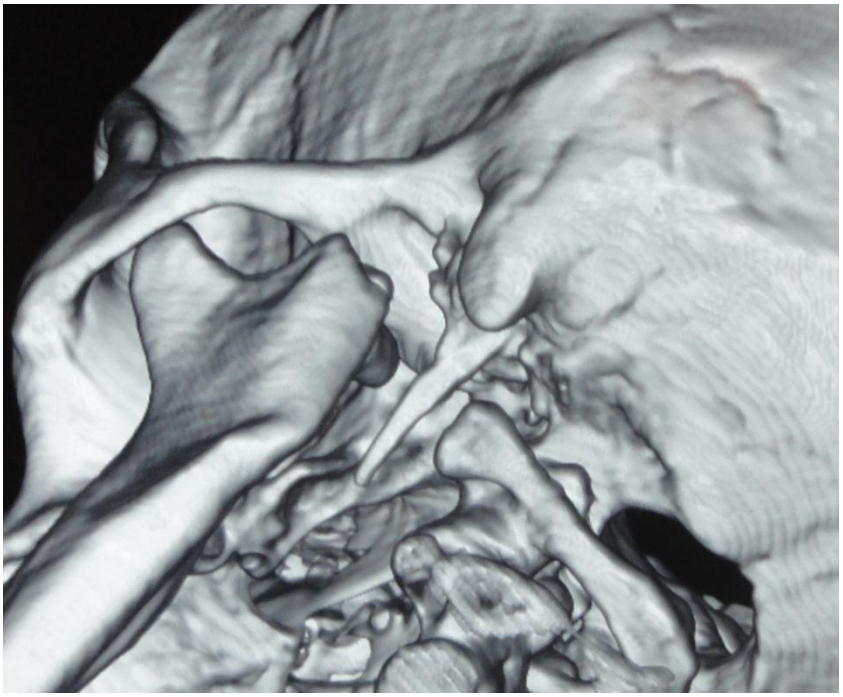
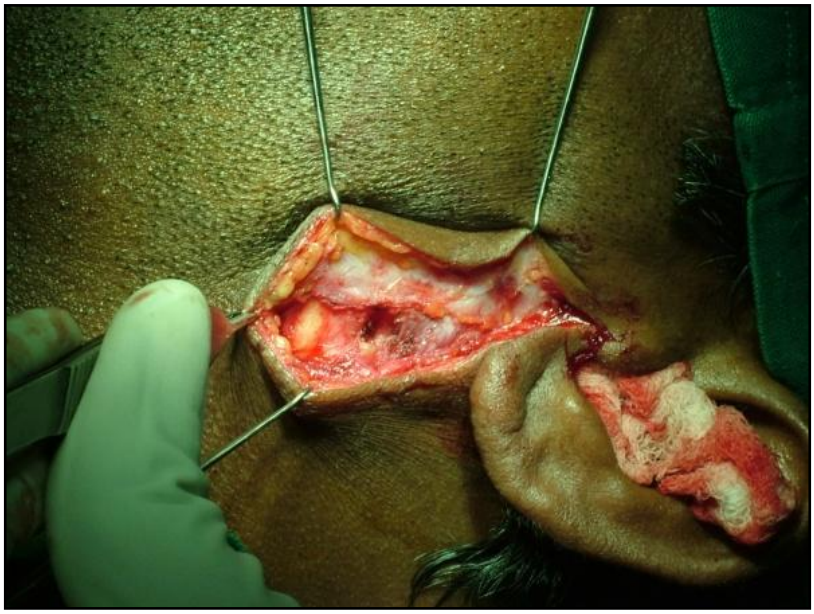


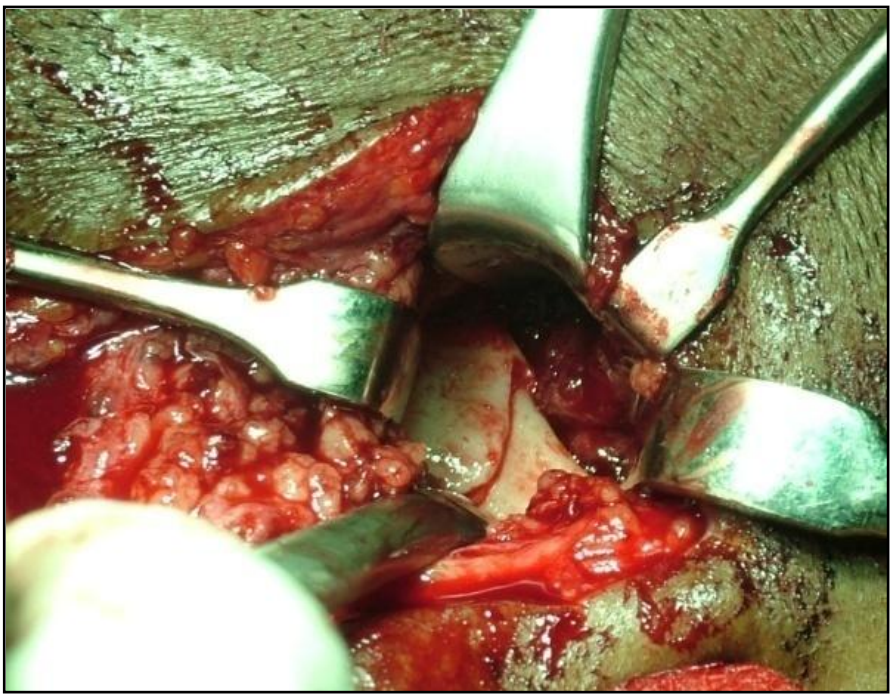
Figure 10 **ARMAMENTARIUM**

FIGURE 11 INTRA-OPERATIVE

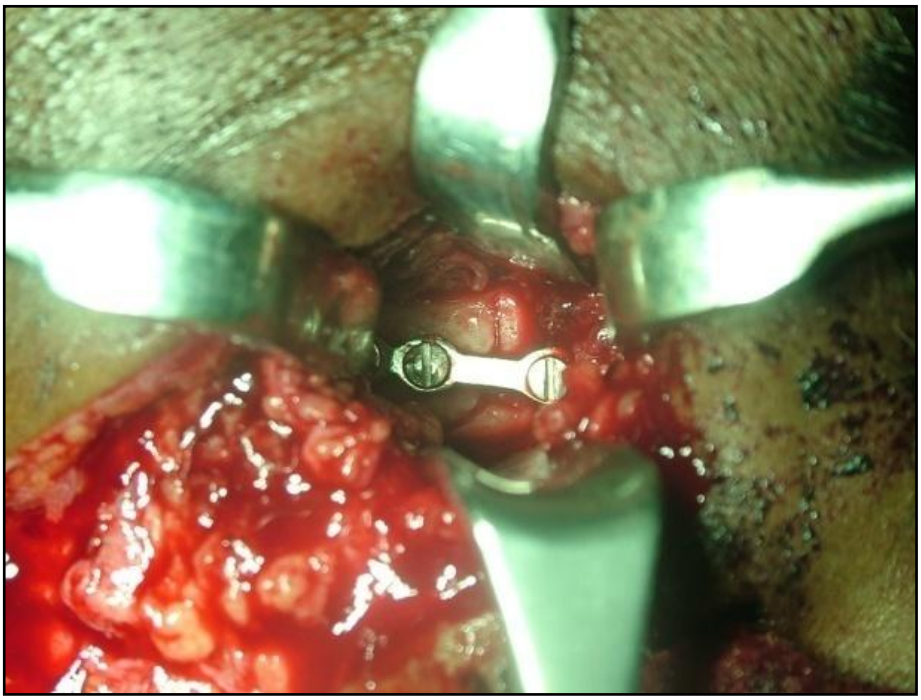
(a)Skin incision



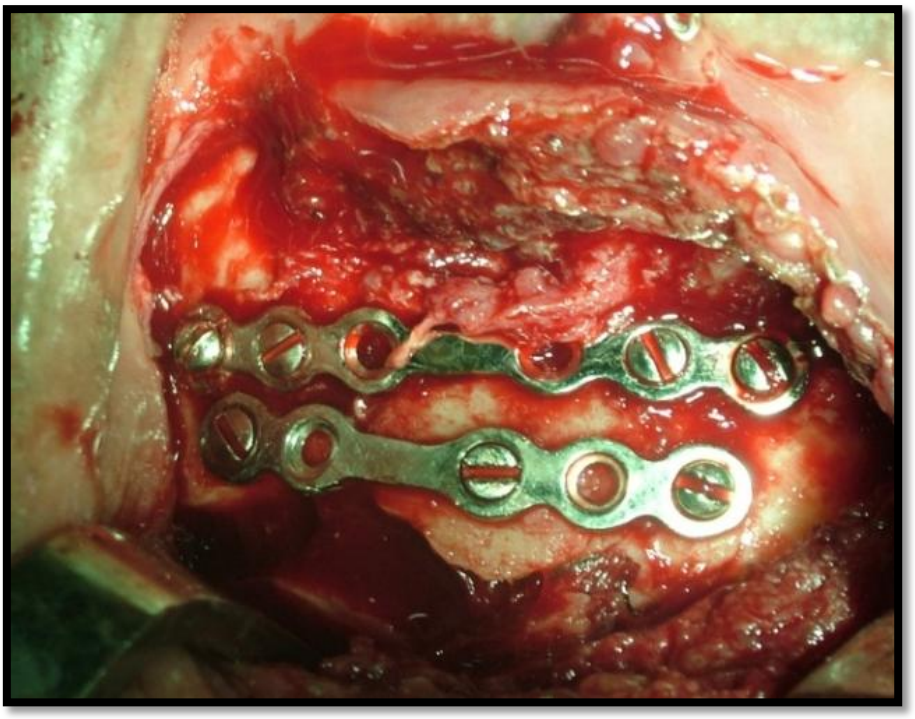
(b)Exposure of parotid capsule



(c) Open reduction



(d) Internal fixation with four hole SS mini plate (with gap)

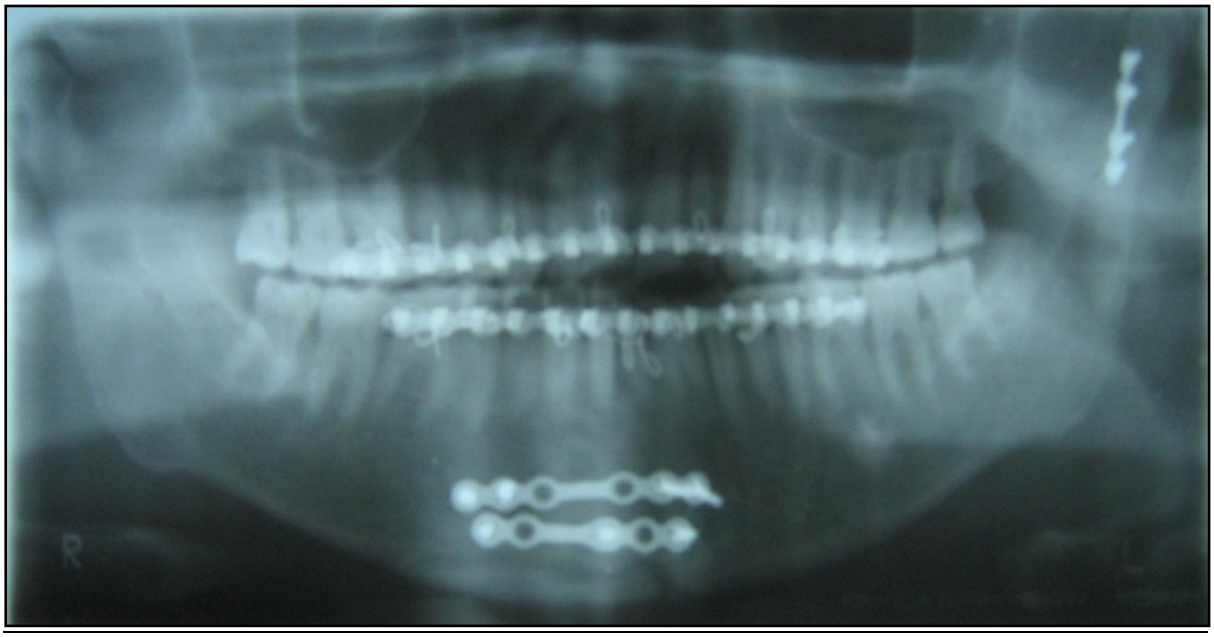


(e) ORIF of parasymphysis fracture

(f) Skin closure

FIGURE 12 POST-OPERATIVE

(a) OPG with mini plates in situ

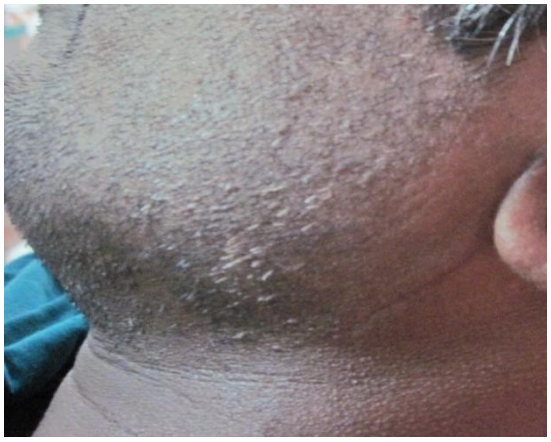


(b) Frontal appearance

(c) Restored occlusion

FIGURE 13 POSTOPERATIVE REVIEW

(a) Inconspicuous scar



(b) Mouth Opening

(b) Vernier Caliper

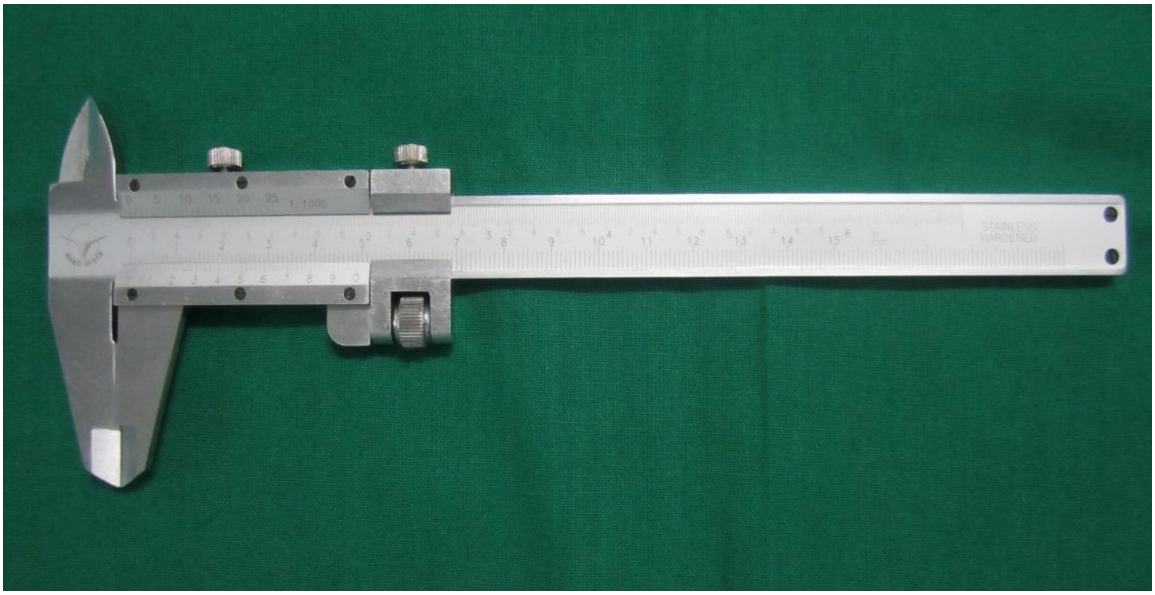
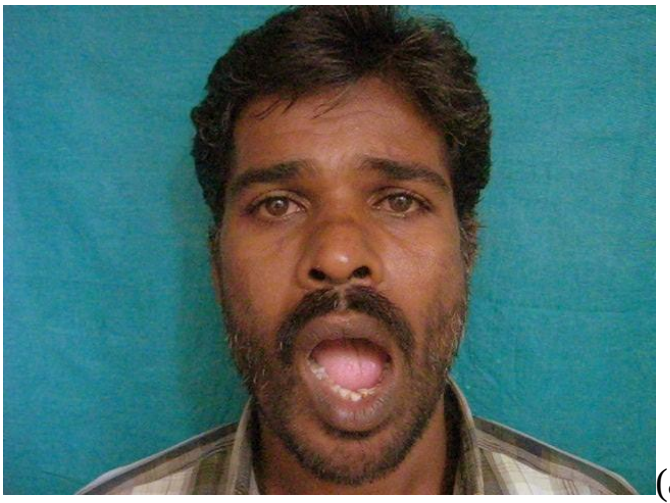
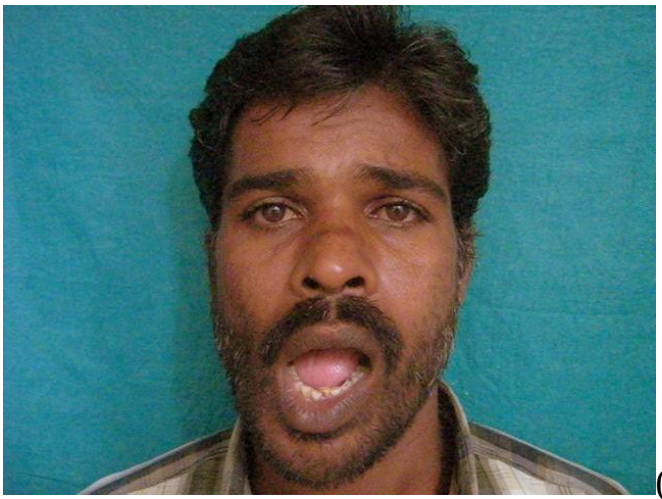


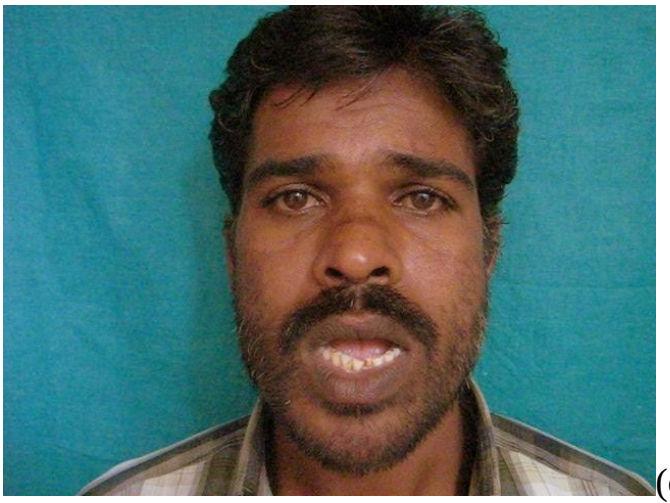
FIGURE 14 EXCURSIVE MOVEMENTS



(a) Left lateral excursion



(b) Right lateral excursion



(c) Protrusion

Figure 15 **FACIAL NERVE ASSESMENT**

RESULTS AND STATISTICS

RESULTS AND STATISTICAL ANALYSIS

The collected patient data were tabulated and statistical analysis was performed. Microsoft Excel 2007 software to derive the mean and standard deviation and SPSS software version 19 was used for statistical analysis. Charts and graphic representations were obtained with the results.

RESULTS

12 patients with 12 unilateral condylar fractures who underwent open reduction and rigid internal fixation by a transparotid approach were included in this study. The location of the fracture was subcondylar in three patients and condylar neck in nine patients (Table a). All 12 fractures were classified into Spiessel and Schroll type IV (Table b). All patients had a co-existent mandibular fracture at another site (Table c) and four patients had associated facial fractures (Table d). 10 fractures were antero-medially displaced and two fractures were laterally displaced (Table e). All surgical procedures and post-operative clinical follow-ups were performed by a single operator.

The study consisted of nine male and three female patients (Chart I). Trauma due to road traffic accidents being the cause in ten patients and self fall being the cause in two patients (Chart II). The mean age of the patients was 28.08yrs (Table f, Chart III). The mean duration of the surgery was 78.75min (Table g, Chart IV). The mean scar length measured was 31.16mm (Table h, Chart V).

Chart I **Gender Distribution (n=12)**

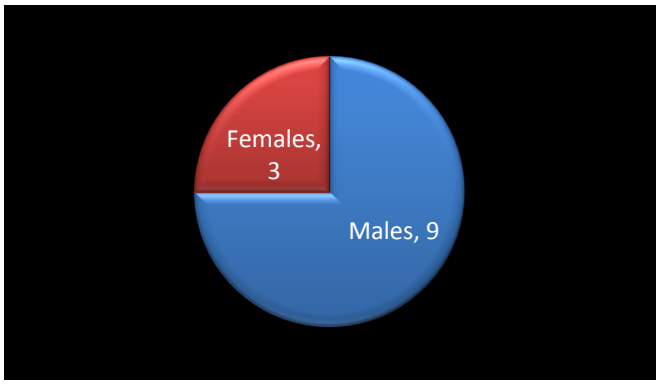


Chart II **Etiology(n=12)**

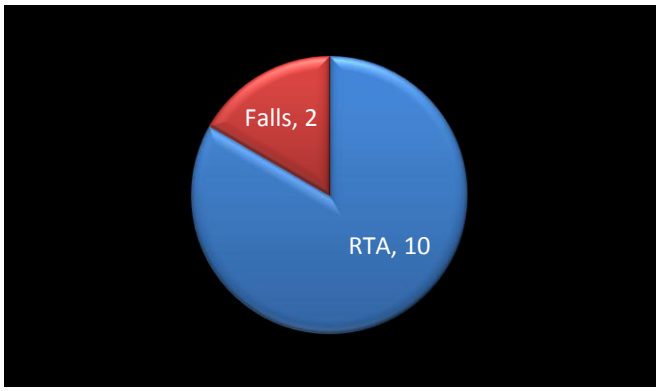


Table f **Age distribution (n=12)**

Patient	1	2	3	4	5	6	7	8	9	10	11	12
Age(yrs)	36	24	31	28	29	23	34	26	21	42	21	22

Chart III

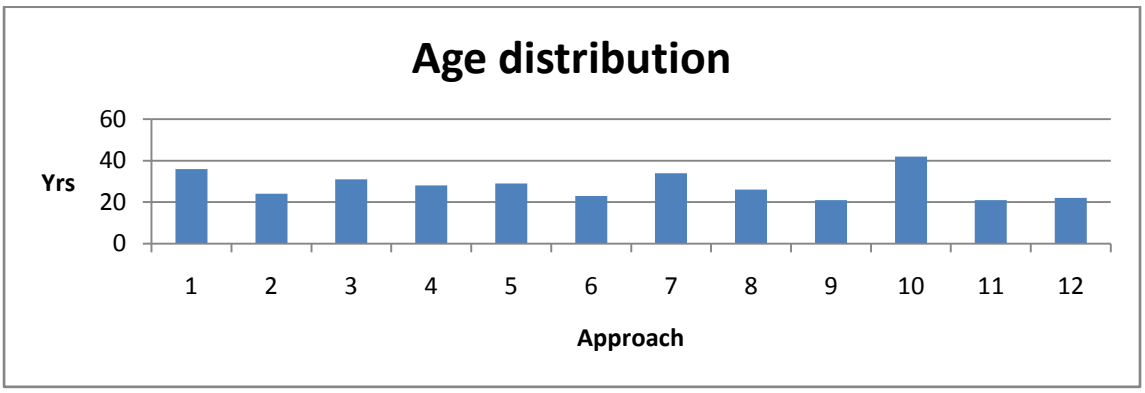


Table g Duration of surgery (n=12)

Approach	1	2	3	4	5	6	7	8	9	10	11	12
Duration (min)	90	85	90	80	60	80	75	70	60	70	90	95

Chart IV

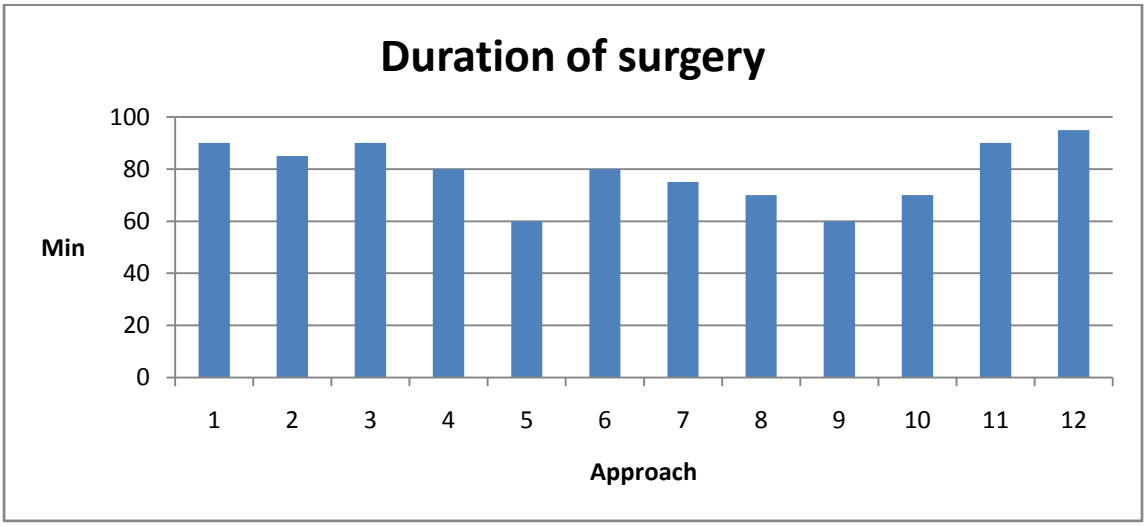


Table h Scar length (n=12)

Approach	1	2	3	4	5	6	7	8	9	10	11	12
Scar length(mm)	31	30	32	31	33	31	32	30	32	30	32	30

Chart V

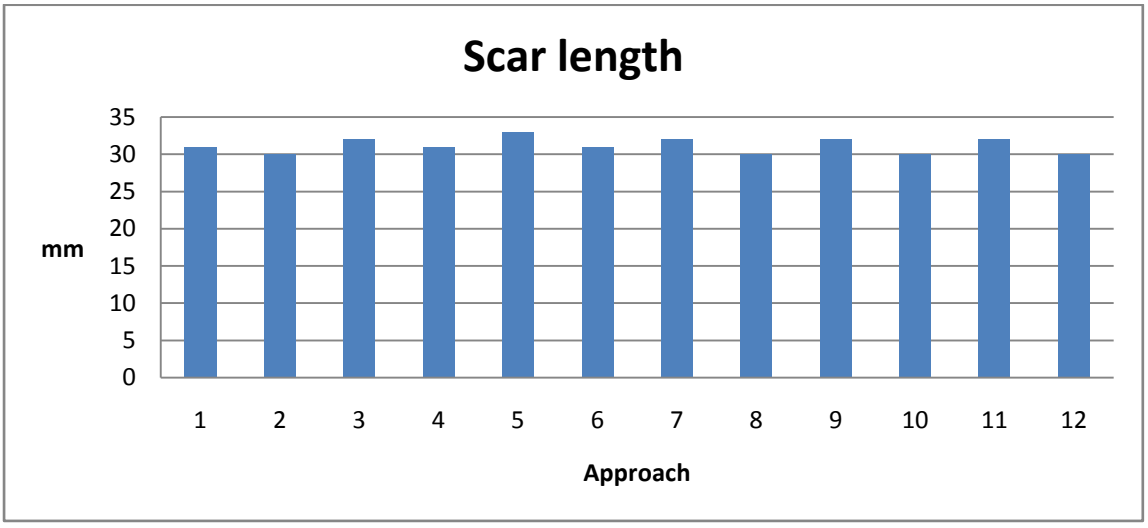


Table i Observations at 2 weeks (n=12)

Approach	1	2	3	4	5	6	7	8	9	10	11	12
Mouth opening(mm)	16	14	14	12	13	16	18	18	14	15	20	19
Protrusion (mm)	1	2	0	0	2	1	0	2	0	1	1	1
(F) Mediotrusion (mm)	2	1	1	1	2	1	1	1	2	1	1	1
(NF) Mediotrusion (mm)	3	2	2	2	3	2	2	2	3	1	2	2
Pain on function (VAS score)	7	6	7	7	7	6	6	7	6	7	6	7

Chart VI Observations at 2 weeks (n=12)

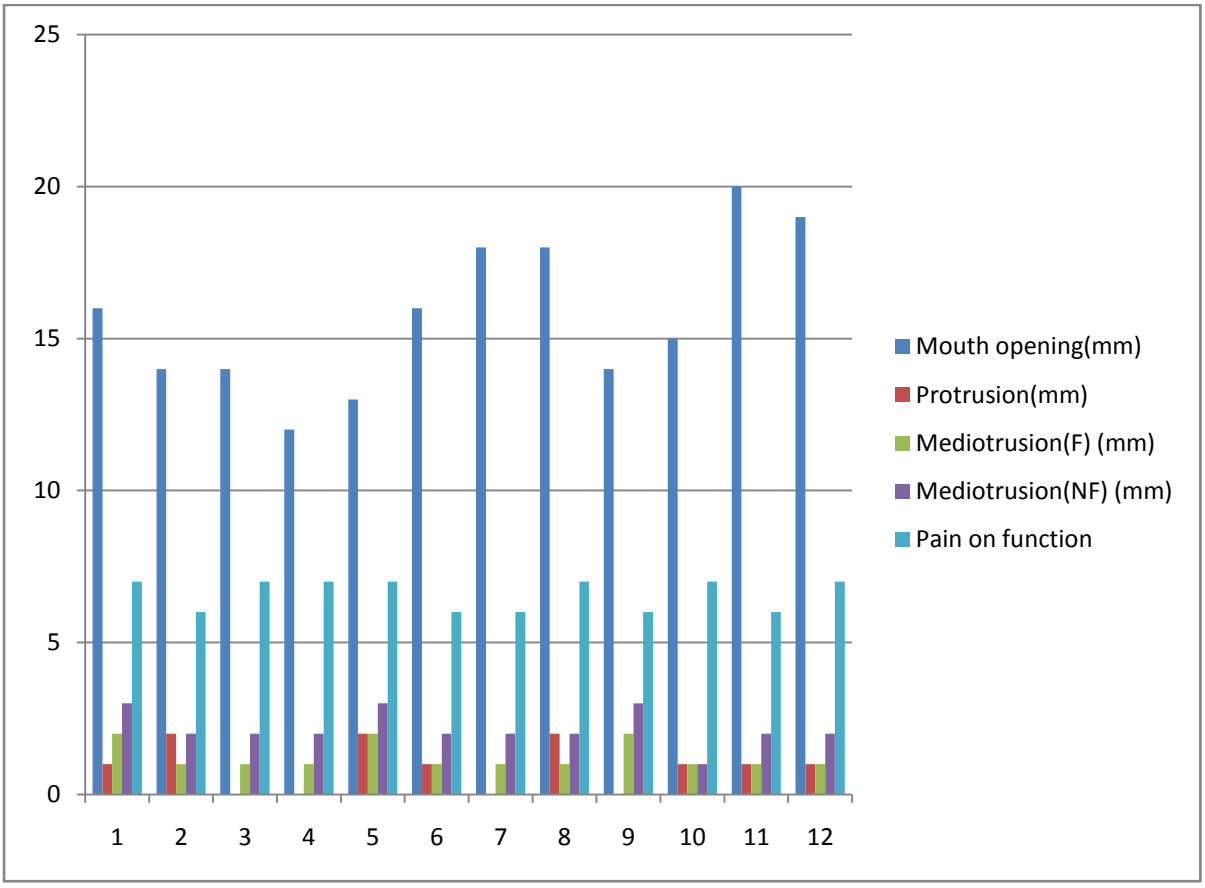


Table j Observations at 6 weeks (n=12)

Approach	1	2	3	4	5	6	7	8	9	10	11	12
Mouth opening (mm)	30	28	28	28	30	26	26	31	28	24	28	28
Protrusion (mm)	3	4	3	3	3	2	4	2	3	2	3	2
(F) Mediotrusion (mm)	4	3	4	3	3	2	5	4	4	4	3	4
(NF) Mediotrusion (mm)	4	3	4	4	4	3	5	5	5	4	4	4
Pain on function (VAS score)	4	4	5	4	5	4	4	5	3	4	4	4

Chart VII Observations at 6 weeks (n=12)

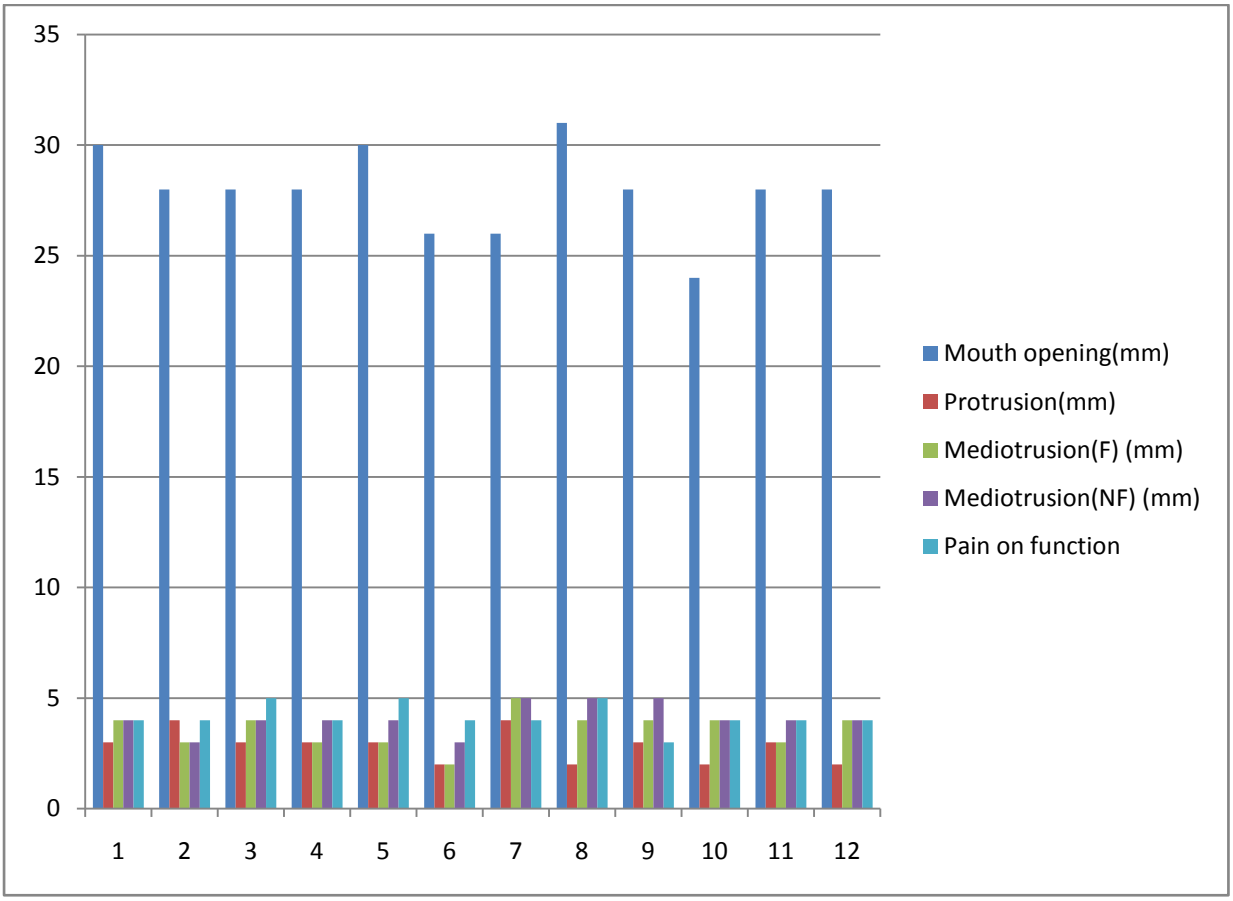


Table k Observations at 3 months (n=12)

Approach	1	2	3	4	5	6	7	8	9	10	11	12
Mouth opening (mm)	35	33	32	34	32	34	30	32	34	28	32	35
Protrusion (mm)	5	5	6	6	5	5	6	6	5	4	5	5
(F) Mediotrusion (mm)	7	6	6	6	7	6	7	8	8	7	6	6
(NF) Mediotrusion (mm)	7	7	7	7	7	8	7	8	8	7	6	7
Pain on function (VAS score)	2	2	3	2	2	2	2	2	1	2	2	2

Chart VIII Observations at 3 months (n=12)

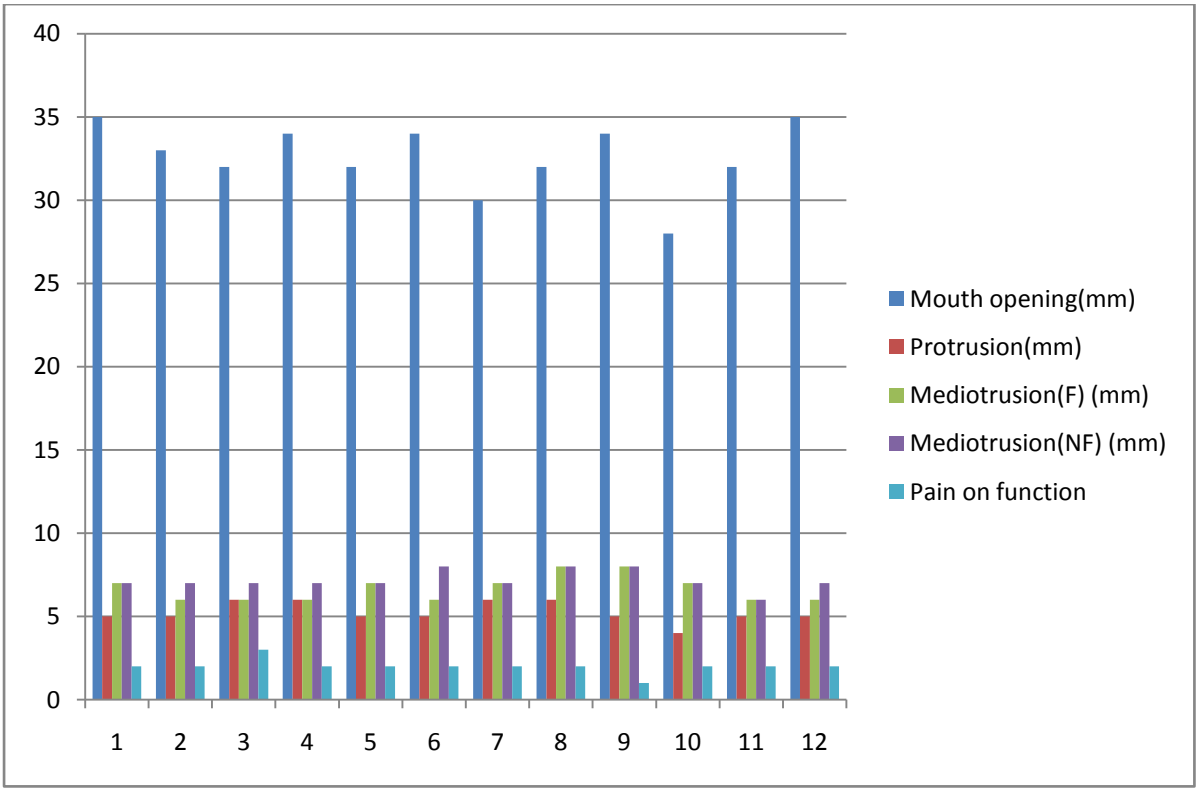


Table l Observations at 6 months (n=12)

Approach	1	2	3	4	5	6	7	8	9	10	11	12
Mouth opening (mm)	40	43	41	39	41	44	40	39	41	39	41	42
Protrusion (mm)	8	8	8	8	7	9	7	7	9	7	9	9
(F) Mediotrusion (mm)	9	9	10	9	9	9	9	10	10	9	10	9
(NF) Mediotrusion (mm)	10	10	9	9	9	11	9	9	10	10	11	10
Pain on function (VAS score)	0	0	1	0	0	0	0	0	0	1	0	0

Chart IX Observations at 6 months (n=12)

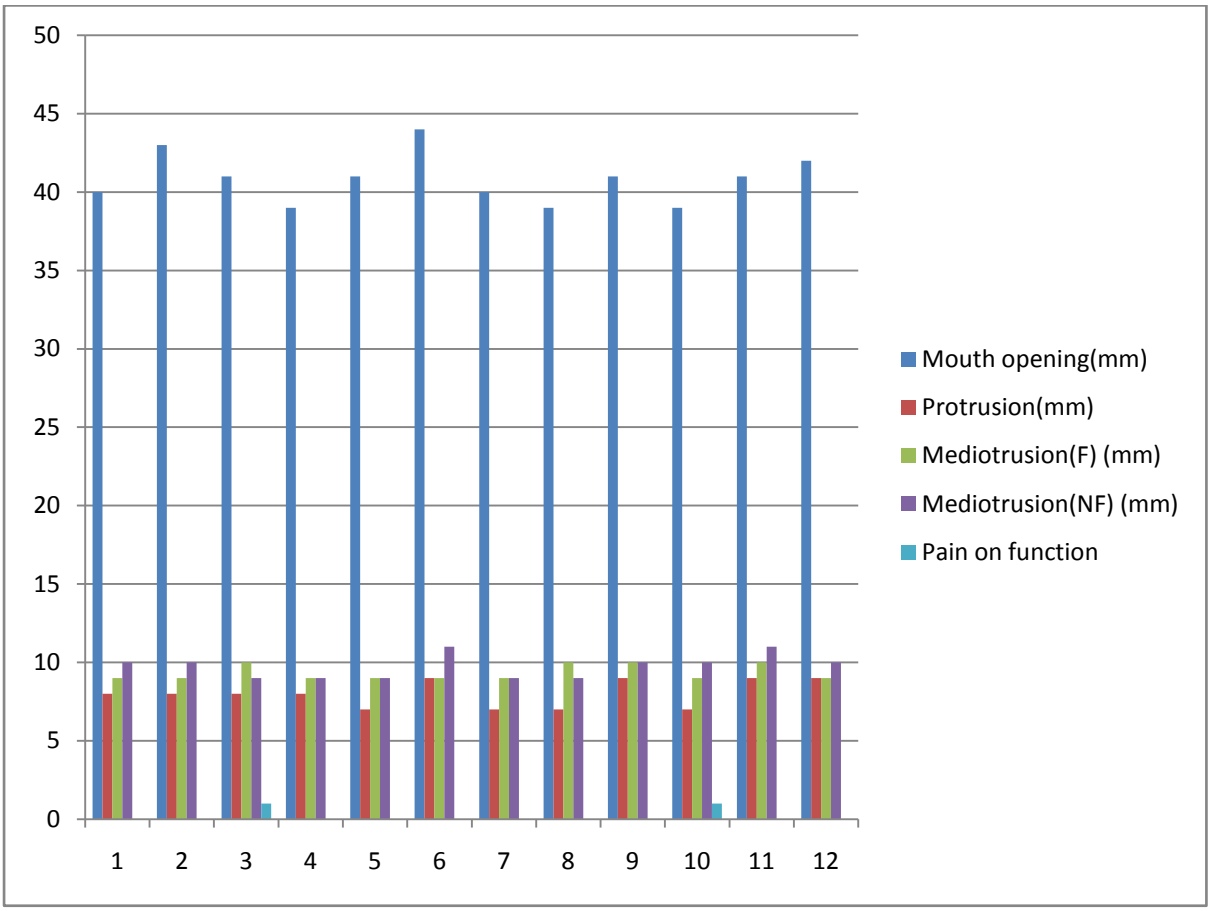


Table m Interpretation of results

	2 weeks	6 weeks	3 months	6 months
Mouth opening (mm)	15.75 (12,20) S.D 2.53	27.91 (24,31) S.D 1.92	32.58 (28,35) S.D 2.06	40.83 (39,44) S.D 1.59
Protrusion (mm)	0.92 (0,2) S.D 0.79	2.83 (2,4) S.D 0.71	5.25 (4,6) S.D 0.62	8 (7,9) S.D 0.85
Mediotrusion(F) (mm)	1.25 (1,2) S.D 0.45	3.58 (2,5) S.D 0.79	6.67 (6,8) S.D 0.78	9.33 (9,10) S.D 0.49
Mediotrusion(NF) (mm)	2.17 (1,3) S.D 0.58	4.08 (3,5) S.D 0.66	7.16 (6,8) S.D 0.57	9.75 (9,11) S.D 0.75
Pain on function	6.58 (6,7) S.D 0.51	4.16 (3,5) S.D 0.57	2 (1,3) S.D 0.42	0.17 (0,1) S.D 0.39

Table n (n=12)

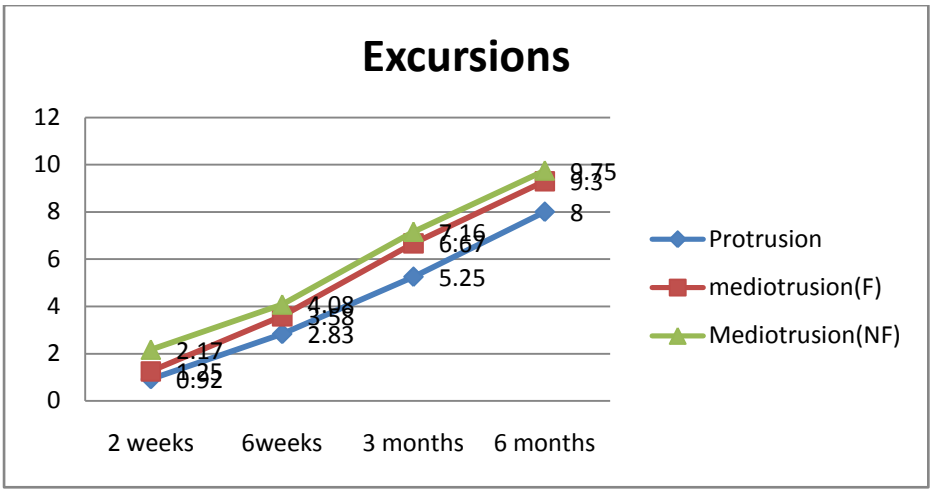
Approach	1	2	3	4	5	6	7	8	9	10	11	12
Salivary fistula*	N	N	N	N	N	N	N	N	N	N	N	N
Wound infection*	N	N	N	N	N	N	N	N	N	N	N	N
Jaw deflection*	N	N	N	N	N	N	N	N	N	N	N	N

(*-Y/N- Yes/No)

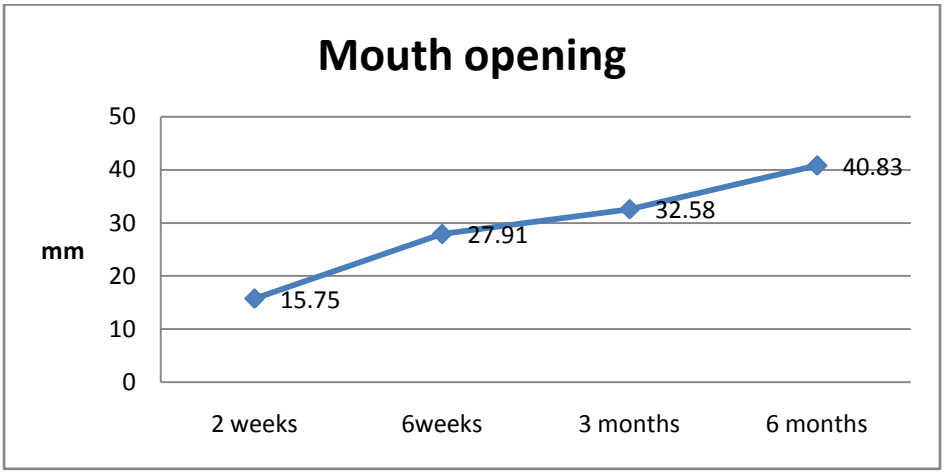
Table o Facial nerve weakness

Approaches	Temporary weakness	Permanent palsy
12	1 (8.33%)	0 (0%)

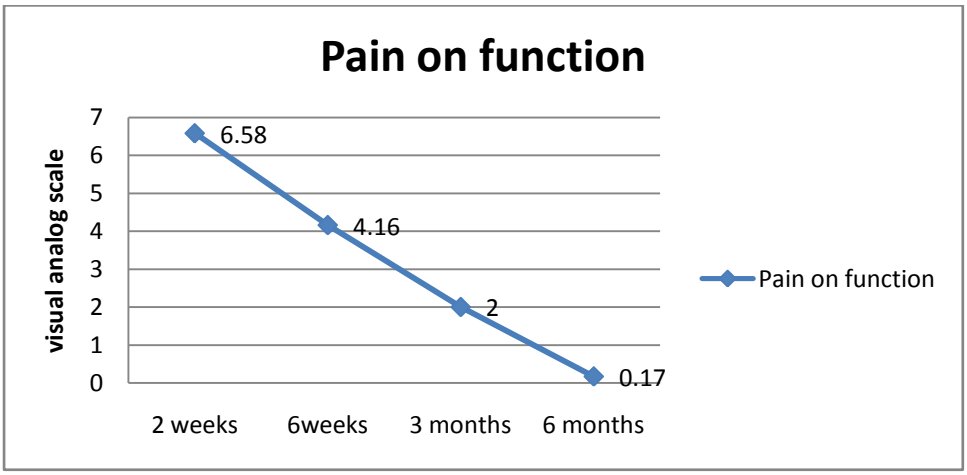
Graph A



Graph B



Graph C



All patients were followed up for the study parameters at 2 weeks (Table i, Chart VI), 6 weeks (Table j, Chart VII), 3 months (Table k, Chart VIII) and 6 months (Table l, Chart IX). The mean value with the maximum and minimum range at a particular review is mentioned along with the standard deviation (Table m).

The functional results according to our clinical evaluation protocol at 2 weeks showed a mean mouth opening of 15.75mm (range 12-20, S.D 2.54). Protrusion in the group had an average of 0.92mm (range 0-2, S.D 0.79), Mediotrusion on the fractured side averaged 1.25mm (range 1-2 S.D 0.45) and on the non fractured side averaged 2.17mm (range 1-3, S.D 0.57).

At 6 weeks, mean mouth opening achieved was 27.91mm (range 24-31, S.D 1.92). Protrusion in the group had an average of 2.83mm (range 2-4, S.D 0.71), Mediotrusion on the fractured side averaged 3.58mm (Range 2-5 S.D 0.79) and on the non fractured side averaged 4.08mm (range 3-5, S.D 0.66).

At 3 months, the mean mouth opening achieved was 32.58mm (range 28-35, S.D 2.06). Protrusion in the group had an average of 5.25mm (range 4-6, S.D 0.62), Mediotrusion on the fractured side averaged 6.67mm (range 6-8 S.D 0.78) and on the non fractured side averaged 7.16mm (range 6-8, S.D 0.57).

At 6 months, the mean mouth opening achieved was 40.83mm (range 39-44, S.D 1.58). Protrusion in the group had an average of 8.0mm (range 7-9, S.D 0.85), Mediotrusion on the fractured side averaged 9.3mm (range 9-10 S.D 0.49) and on the non fractured side averaged 9.75mm (range 9-11, S.D 0.75).

None of the patients developed wound infection and there was no case of salivary fistula. No patient's developed malocclusion and there was no permanent deflection of the jaw on mouth opening (Table n).

Facial nerve weakness (House-Brackmann Grade II) was seen in only one patient (8.33%) in the immediate postoperative period which resolved in the second week (Table o).

Mean pain on function scores at two weeks, six weeks, three months and six months intervals were 6.58 (range 6-7 S.D 0.51), 4.16 (range 3-5 S.D 0.57), 2 (range 1-3 S.D 0.42) and 0.17 (range 0-1 S.D 0.39) respectively.

All mandibular excursive movements (Graph A) and maximum mouth opening (Graph B) showed an increasing trend at each review. Pain on function (Graph C) showed a decreasing trend on subsequent visits.

Inferential statistics

Within group differences in various parameters at 2 weeks and at 6 months were compared using the Wilcoxon Signed Rank test, which is the non parametric equivalent of Paired t test. This test was chosen as the data was non-normal in distribution. For all comparisons, p value of < 0.05 was considered to be statistically significant.

Table p: Comparison of **Mouth Opening** of study subjects at 2 weeks and at 6 months

Mouth opening	N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	Z value	p value
at 2 weeks	12	15.75	2.53	12.00	20.00	-3.068	0.002*
at 6 months	12	40.83	1.59	39.00	44.00		

*Highly significant

Table q: Comparison of **Protrusive movement** of study subjects at 2 weeks and at 6 months

Protrusion	N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	Z value	p value
at 2 weeks	12	0.92	0.79	0	2.00	-3.087	0.002*
at 6 months	12	8.00	0.85	7.00	9.00		

*Highly significant

Table r: Comparison of **Mediotrusive movement (F) (mm)** of study subjects at 2 weeks and at 6 months

Mediotrusion	N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	Z value	p value
at 2 weeks	12	1.25	0.45	1.00	2.00	-3.134	0.002*
at 6 months	12	9.33	0.49	9.00	10.00		

*Highly significant

Table s: Comparison of **Mediotrusive movement (NF) (mm)** of study subjects at 2 weeks and at 6 months

Mediotrusion (NF)	N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	Z value	p value
at 2 weeks	12	2.17	0.58	1.00	3.00	-3.108	0.002*
at 6 months	12	9.75	0.75	9.00	11.00		

*Highly significant

Table t: Comparison of **Pain on function** of study subjects at 2 weeks and at 6 months

Pain on function	N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	Z value	p value
at 2 weeks	12	6.58	0.51	6.00	7.00	-3.153	0.002*
at 6 months	12	0.17	0.39	0	1.00		

*Highly significant

The results of the comparison of mouth opening (Table p), protrusion (Table q), mediotrusion (F) (Table r), mediotrusion (NF) (Table s), and pain on function (Table t) at 2 weeks and 6 month intervals were found to be highly significant.

DISCUSSION

Discussion

At about the 5th week of intrauterine life, an area of mesenchymal condensation can be seen above the ventral part of developing mandible[72]. This develops into a cone-shaped cartilage by about the 10th week and starts ossification by the 14th week. It then migrates inferiorly and fuses with mandibular ramus in about 4 months. Much of the cone shaped cartilage is replaced by bone by the middle of foetal life, but its upper end persists into adulthood acting both as a growth cartilage and an articular cartilage.

The condyle of mandible is composed of cancellous bone covered by a thin layer of compact bone. The trabaculae are grouped in such a way that they radiate from the neck of the mandible and reach the cortex at right angles, thus giving maximal strength to condyle. Remnants of the cartilage may persist into old age. Unlike metaphyseal primary cartilage of long bones, the hyaline cartilage of condyle is not organized in parallel rows of cells at interface between forming bone and cartilage. Therefore, this cartilage is usually referred to as secondary cartilage[73]. The condylar growth rate increases at puberty reaching a peak level between 12 ½ - 14 years. The growth ceases at around 20 years of age.

Huelke has shown that isolated mandible is liable to particular patterns of distribution of tensile strain when forces are applied to it. Anterior forces applied to the symphysis menti, over mental foramen or over the mandibular body, lead to strain at the condylar necks and along the lingual plates in the opposite molar region. The energy required to fracture the mandible is in the order of 44.6-74.4kg/m[24].

Fractures of the condylar process of the mandible are common and account for 8-50%[2] of the mandibular fractures reported in literature. Various mechanisms of injury have been described to result in condylar fractures[24].

1. Kinetic energy imparted by a moving object through the static tissues of the individual. e.g.-Sports activities
2. Kinetic energy derived from the movement of the individual and expended upon a static object. e.g.- 'Parade ground' fracture
3. Kinetic energy which is a summation of forces derived from the combination of a moving object and a moving individual which results in more severe condylar trauma. e.g. - Road traffic accidents.

The zygomatic arch gives some measure of protection to the condyle from direct trauma, so that the impact which causes condylar fractures is usually an indirect one, either through the symphysis or through the body of the mandible. The usual site of fracture is not at the anatomical neck but obliquely downwards and backwards from the sigmoid notch to a point above the middle of the posterior border of the ramus. This is related to the muscular response to the injury which, with the posterolateral condylar displacement along the axis of the lateral pterygoid muscle, would initiate a stretch reflex in that muscle. Fractionally later, contraction of the masseter and medial pterygoid muscles would impose an area of maximum strain just above the massetric insertion (Figure 16). The fractured condyle, most commonly, is displaced anteromedially due to the pull of the lateral pterygoid muscle on the fractured condyle. Lateral displacement can also occur but it is not common due to the presence of a strong lateral ligament. In rare instances, the thin tympanic plate that constitutes part of the posterior non-articular portion of the glenoid cavity can be fractured, with distortion of the bony meatal wall. The condyle can also get displaced superiorly into the middle cranial fossa.

Depending on the direction and nature of trauma, all types of fractures of the condylar process are possible, including greenstick fracture, simple transverse fracture, slightly oblique fracture, medial or lateral shearing fracture, bending fracture with wedging, comminuted fracture and compression fracture[74]. These may occur at different levels of the condylar

process. Apart from fractures with rupture of the external auditory canal, these are normally simple fractures. Of the many types of fractures associated with the articular process, the bending and shearing types are the most common.

The clinical features of condylar fracture are pain in the temporomandibular joint region, trismus and inability to appreciate the condylar translation on palpation over the joint, malocclusion and bleeding from the ear. A displaced unilateral condylar fracture is characterized by shortening of the ramus on the ipsilateral side leading to premature contact of the molar, thereby producing a posterior open bite on the contralateral side. There is deviation of the mouth to the ipsilateral side on mouth opening. A bilateral displaced condylar fracture is characterized by molar gagging on both sides, producing an anterior open bite.

Following clinical analysis, radiographs play a fundamental role in determining the level of fracture and degree of dislocation of the fracture as well as relationship of the head of the mandible to the fossa. Orthopantomograms, postero-anterior skull view and Towne's view are recommended for diagnosing condylar fractures. However, CT scan is the gold standard for the assessment of condylar fractures.

The numerous different initial conditions and surgical possibilities, as well as the individual characteristics of the patient, mean that no hard and fast rules can be laid down for the treatment of condylar fracture of the mandible. Widely varying factors, such as the age of the patient, condition of the teeth, occlusal relationship, location and nature of the fracture, concominant injuries, surgical possibilities and the profession and personality of the patient, must all be taken into account when evaluating as to whether surgical treatment is advisable. The difficulty in deciding whether to pursue conservative or surgical treatment lies in the correct assessment of the factors involved. The level of fracture on the condylar process and

the type of fracture are the most decisive factors in determining whether open surgical treatment is advisable or not.

Bony union, after condylar fractures appears to occur regardless of whether intermaxillary fixation is employed or not unlike other regions in the mandible which require rigid fixation. Hence, the two main schools of thought, conservative and surgical treatment, were advocated. The objective of conservative treatment is to allow bony union to occur, where there is no significant displacement or dislocation, to produce an acceptable functional pseudoarthrosis by re-education of the neuromuscular pathways. In conservative treatment for condylar fracture, arch bars are applied to the maxilla and mandible and the jaw is kept in intermaxillary fixation for two weeks. The ligatures are subsequently removed and replaced by a monoblock that contains a premature contact as a point of leverage (hypomochlion) in the molar region to relieve the joints. The purpose of this exercise is to slowly break the masticatory spasm normally encountered after intermaxillary fixation and to train the mouth to open straight[74]. The aim is to encourage active movement of the jaw as early as possible, provided the patient is able to bring his / her teeth into normal occlusion.

On the contrary, the surgical treatment works with the objective of repositioning the fractured condyle to its anatomical location. This is achieved by approaching the condyle by extra oral or intra oral approaches, reducing it back to its anatomic relationship with the mandibular fragment and fixing it in that position. Regardless of how the fractures are treated, biologic adaptations must occur in the condyle and glenoid fossa to provide the patient with satisfactory outcome. This is the reason why different treatment options in treating condylar fractures have all produced satisfactory outcomes[54]. However, open treatment of condylar process fractures requires fewer adaptations with the masticatory system to provide a favourable functional outcome.

A consensus was obtained following a two day international conference (1999) on the management of a fractured condyle[75]. The following criteria were defined for successful outcome

1. Return to pre-injury occlusion.
2. Normal jaw opening (about 40mm).
3. Pain free joint.
4. Absolute minimal morbidity of surgery.

The age of the patient is of decisive importance to prognosis and therapy. With dislocation fractures in children and young people, since growth is still taking place, there is a good chance for efficient functioning later. In adults with dislocated condylar fractures and shortening of the condylar process, if left uncorrected surgically, will result in severely limited motion, loss of opposing condylar support and traumatic occlusion. These are extremely difficult to correct later with physical or prosthetic measures and offers poor results. Severely limited movement in one temporomandibular joint leads inevitably to hypermobility of the contralateral joint. Contralateral straining of the temporomandibular joint on the non fractured side disposes the joint to discopathy, which can eventually lead to arthrosis[74].

The mode of treatment of condylar fractures varies in the child and adult due to the inherent anatomical variations of the paediatric and adult condyle. There is a consensus on conservative treatment of paediatric condylar fractures as they could completely regenerate a new condylar process. The process was termed “restitutional” remodelling[54]. However, with advancing age, the condylar process has less remodelling ability and regenerates with an atypical morphology. This is called “functional” remodelling[54]. Injury to the joint does not always limit the amount of mouth opening because the condylar rotation can compensate for

limited translation but it does limit mandibular protrusion and lateral excursions as these movements are more dependent on condylar translation[54]. Partial healing after fracture of the condylar process, which is normally tolerated by most patients through habituation but in objective terms represents permanent damage, has often been the goal of active surgical treatment to complete restoration of function where possible. If such fractures are treated by open reduction and internal fixation, that will sustain physiotherapeutic exercises, condylar support and normal joint function can be fully restored.

The treatment of adult condylar fractures has been a controversy for the past six decades resulting in the proposal of various indications for open treatment. Though initial studies were in favour of closed reduction primarily due to the risk of facial nerve damage by transcutaneous approaches, current literature[4] presents evidence that open reduction and internal fixation by transcutaneous and intraoral approaches result in early return to function and quick rehabilitation compared to closed treatment. The obvious advantage of good function after open reduction and internal fixation is due to the restoration of the lateral pterygoid muscle after osteosynthesis of the condyle.

The introduction of plate osteosynthesis for condylar fractures has made conservative treatment methods with maxillomandibular wiring largely redundant. The stress caused to the patient by maxillomandibular fixation, including associated hygiene problems, enormous difficulties in eating leading to weight loss, fear of suffocating at night and slow rehabilitation that is complete only after more than two months can be eliminated or at least significantly reduced with the help of stable osteosynthesis.

Various methods of osteosynthesis used are single 2.0mm mandibular mini plate, two mandibular mini plates at the anterior and posterior border, a 2.4mm plate and a mini dynamic compression plate[76]. We preferred to use a single 2.0mm mandibular mini plate for

osteosynthesis of condyle because it produces a stable osteosynthesis and literature[65] supports its use. However, Meyer[46], based his experimental study on photoelastic analysis of bone deformation in the region of the mandibular condyle during mastication has showed that, compressive stress patterns were found along the posterior border of the ramus and tensile stress patterns along the anterior border of the ramus and in the zone situated below the sigmoid notch. These findings suggest that during mastication, the mandible is subjected to saggital forces which tend to straighten the mandibular angle. He implied that, in the condylar region, osteosynthesis plates have to be positioned close to the tensile strain lines as has been recommened for other parts of the mandible when applying semi-rigid fixation. He described the ideal lines of osteosynthesis for condyle to run obliquely below the mandibular notch (Figure 17) and do not correspond to the area in which internal fixation is usually applied. Based on this principle, Trost[60] has treated condyle fractures with Modus TCP (trapezoidal plates) and produced successful results.

Surgical approach to the condyle is a contentious area. Currently there is no consensus on the surgical approach of choice for open treatment. The choice of approach basically depends on the location of the fracture, the morbidity of facial nerve damage and the cosmesis of the approach. Intra oral approaches is technically demanding and extra oral approach risks facial nerve injuries and visible scarring.

Surgical access to the condylar process to perform open reduction and internal fixation requires exposure and dissection of soft tissues from the condyle to permit manipulation and attachment of fixation devices. Hence, if blood supply is to be maintained, one should choose a surgical approach that can minimize the amount of soft tissue stripping from the fractured condyle and maintain as much as possible the attachment of the TMJ capsule and lateral pterygoid. Hence, in a retromandibular approach, soft tissues from the

FIGURE 16 Relations of muscles to fracture site

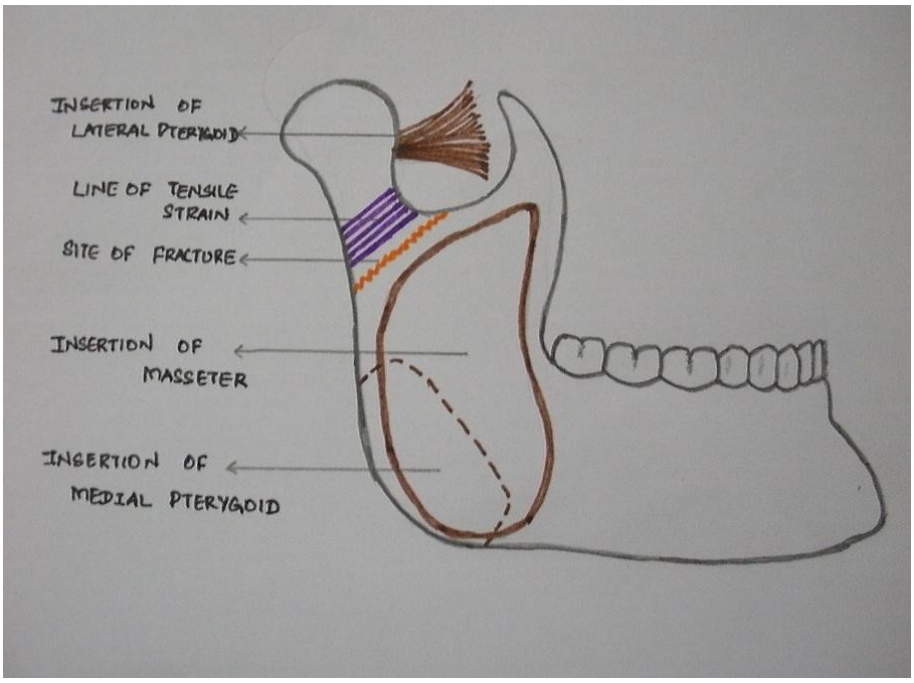
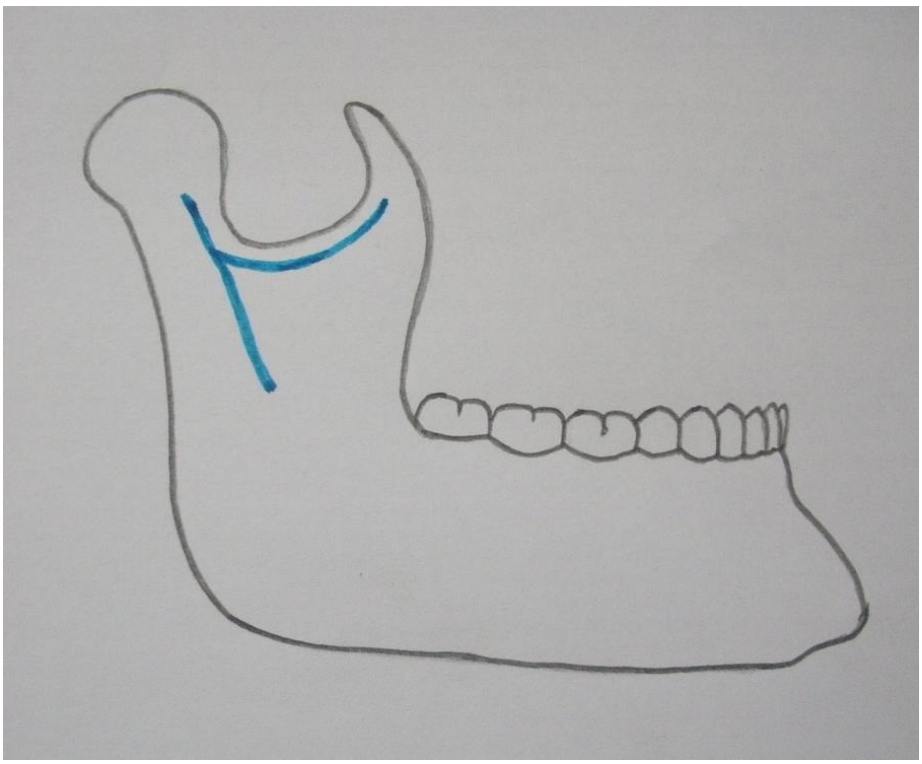


FIGURE 17 Meyers lines of osteosynthesis for condyle



inferior portion of the condyle upto the point where the capsule attaches can be stripped, leaving the capsule intact.

The ability to perform anatomic reductions is based largely on the access and the visibility provided by the surgical approach one chooses. Surgical approaches are chosen primarily based on the location of the fracture and the type of osteosynthesis to be applied. The retromandibular approach has been shown to be closest to the site of fracture and allows perpendicular fixation of mini plates.

The commonly favoured approach to the condyle are the submandibular, pre-auricular, retromandibular approaches, endoscopic assisted intraoral approach and the rhytidectomy approach.

The classic retromandibular approach, proposed by Hinds and Girroti[14] in 1967, was modified by Koberg and Momma[21]. This approach to the condyle was achieved by a retroparotid approach which produced a high incidence of facial nerve injury. The transparotid approach is performed through the parenchyma of the parotid gland, in the window between the marginal mandibular and the lower buccal branches of the facial nerve. No attempt was made to locate the facial nerve branches. If they were encountered during surgery, 10-15mm anterior and 5mm posterior dissection was done that provided retraction of the nerve. We encountered the lower buccal branch in one case which was safely retracted. A transient weakness of marginal mandibular nerve was observed in one case (8.33%) which resolved in 2 weeks. Though the buccal branches are retracted more superiorly, paresis was not seen because of the presence of multiple buccal branches and a lush anastamosis (70%) [33] between zygomatic and buccal branches around the orbicularis oris and upper lip. No case of greater auricular nerve disturbance or Frey's syndrome was identified.

The pre-auricular approach has been advocated for treatment of high condylar fractures. In this approach, the joint need not be entered. Instead, the capsule at the inferior portion of the joint can be dissected and the periosteum can be incised below the level of the capsule and the fracture is visualised. Several disadvantages listed with this approach are, firstly, it does not provide access to the mandibular angle to aid in inferior distraction during reduction. Secondly, the amount of mandibular ramus exposure that one achieves is extremely limited, which makes bone fixation difficult. Thirdly, this approach will often result in more stripping of soft tissues from the condylar fragment, occasionally leading to a free bone graft. This approach had its advocates in the days of wire fixation and hence we rarely use this approach for the treatment of condylar fractures with plate and screw fixation.

The submandibular approach used for treating condylar fractures has the only advantage of access to the mandibular angle for distraction. This manoeuvre can be useful for reduction of medially displaced condylar process. There are many disadvantages. The main difficulty is the great distance from the skin incision to the fracture. The only way to improve access is to extend the incision so that more retraction of the tissue superiorly is possible. The submandibular approach makes reduction difficult, especially those condyles that are medially displaced and hence this approach is not always favoured.

The rhytidectomy or facelift approach to condylar fractures was described by Zide and Kent[3] in 1983 involves dissection of the facial nerve and blunt dissection through the parotid gland and masseter muscle. The advantage of this incision is that being located in more hidden locations, good access similar to a retromandibular incision is obtained and a less conspicuous facial scar. The only disadvantage is the added time required for closure.

The intra oral approach was first described by Silverman[8] in 1925 and was reserved for low subcondylar fractures because of access difficulties. The approach is similar to a

transoral vertical ramus osteotomy with an incision extending over the anterior border of the mandibular ramus and extending into the lower buccal sulcus. With the advent of endoscopic assistance, the treatment with this approach has expanded. The two great advantages of this approach are firstly, a visible scar is avoided and secondly the risk of facial nerve damage is minimized. The major disadvantage of this approach is the limited access. Some mandibular rami are oval shaped in cross section, which makes visualization posterior to the midramus very difficult. Thus it is also difficult to reduce some medially displaced fractures. Adequacy of reduction is difficult to ascertain and application of fixation can be problematic and trans-buccal trocar is needed for fixing the screws. Lack of access frequently prevents precise positioning of the plate. The advent of endoscopic assisted approach has circumvented these disadvantages and hence is being used extensively. However, endoscopic technique of open reduction and internal fixation requires a steep learning curve[77].

A review of literature confirms that surgical approaches to the condyle other than the retromandibular transparotid approach are associated with a high incidence of temporary facial nerve paresis. The temporal and zygomatic branches are vulnerable in the rhytidectomy approach described by Zide and Kent[3] and also with the preauricular approach. In the submandibular approach where a subplatysmal dissection is performed, the incidence of temporary facial nerve palsy varies from 11-37%[3, 78]. An increased distance between the incision and the condylar neck appears to be the main contributing factor. Intraoral approaches may also put the facial nerve at risk particularly when trans-facial trocars are used for plate fixation.

The most important parameter in this study, the facial nerve weakness reported after the trans parotid approach is 8.33% (1 case) which is better than the submandibular approach (Tasanen 37%)[78]. Our results are also comparable to the results of the transparotid approaches

described in literature (V.Narayanan 3%)[6], (Yang 18%)[64], (J.J.Downie 14%)[61], (Chossegros 11%)[35], (Klatt 10%)[63], (Choi 20%)[41].

The mean age of the patients in our study was 28.08yrs with majority (8 patients) in the third decade. Men have outnumbered women by three times. The most common etiology has been road traffic accidents involving 10 patients. This is probably attributed to the frequent use of two wheelers for transport. The mean duration of the surgery was 78.75 minutes which is favourable in terms of the economics and also the advantage of subjecting the patient to a short time in general anaesthesia.

All the patients demonstrated good healing post operatively and none of the patients developed a salivary fistula, the reason being the meticulous watertight closure of the parotid capsule in all the cases. Treatment options available if a salivary fistula or a sialocele were to develop are aspiration, pressure dressings, anti-sialagogues (propantheline bromide), radiation therapy, parasympathetic denervation (tympanic denervation), cauterisation of the fistula.

The scars were barely visible and their mean length was 31.16mm. Excellent cosmesis was achieved as the scar was hidden in the natural depression behind the mandible. In all the cases, a stainless steel 2.0mm four hole with gap stainless steel mini plate and 2.0mm×6.0mm stainless steel screws were used. There were no cases of fracture of osteosynthetic plate in our study and a single plate provided adequate fixation. None of the patients had any permanent deflection of the jaw on mouth opening.

The functional results reported in the literature were similar at the six months and fifteen year follow up intervals, suggesting that long term follow up may not be necessary in evaluating therapy[37]. Hence, our functional results at six months after open reduction and internal fixation of condylar fractures by a retromandibular transparotid approach are

promising. A comparison of our results with those described in literature has provided information to evaluate the success of this approach.

The functional results at six months follow-up showed a mean mouth opening of 40.83±1.58mm (range 39-44). Protrusion had an average of 8.0±0.85mm (range 7-9), Mediotrusion on the fractured side averaged 9.33±0.49mm (range 9-10) and on the non fractured side averaged 9.75±0.75mm (range 9-11). Statistical analysis of the various parameters at two weeks and at six months postoperatively has been found to be highly significant. These functional results have been found to equal the normal excursion levels[49] and comparable to the results obtained in the study by Jan Klatt[63]. The mean difference between the mediotrusion on the fractured side (1.25±0.45mm) and that of the non-fractured side (2.57±0.58mm) was minor during the evaluation at two weeks and were almost similar at the subsequent follow-up intervals.

Occlusion was evaluated with the help of an orthodontist and was found to have been restored to their pre-injury status. Ten patients had a stable postoperative occlusion and hence did not require any form of intermaxillary fixation. Two patients required intermaxillary elastics for a period of five days to guide them to their preinjury occlusion. No objective discrepancies were noted on evaluating permanent deflection of the jaw on mouth opening.

Evaluation of the patients for pain on function based on the visual analog scale has shown that the scores have decreased gradually as the postoperative duration increased. All the patients were initially managed by NSAID's during the immediate postoperative period. Two patients (2 females) who reported with persistent pain after the sixth week postoperative review were prescribed Diclofenac sodium (50mg) twice daily for five days, after which the symptoms relieved.

Discussion

There has been no consensus as to the ideal approach to the condyle fractures in literature. In this study, we have evaluated the morbidity associated with a single approach. A comparison of this approach with an intra oral endoscopic approach or with similar transcutaneous approaches in the future studies would be helpful in deciding on performing the approach with the least morbidity and good functional results. We also wish to undertake a study to identify an ideal approach to condylar head fractures particularly in bilateral fractures which require internal fixation.

SUMMARY AND CONCLUSION

Summary and Conclusion

- In this study, men have outnumbered women by three times and road traffic accidents have been the most common cause.
- There is a low incidence of transient facial nerve weakness (8.33%) with the transparotid approach and also good cosmetic results have been achieved in this study.
- The functional results obtained in our study after open reduction and internal fixation of condylar fractures through a transparotid approach is excellent to warrant its routine use in condylar neck and subcondylar fractures.
- We recommend single 2.0mm four hole miniplate placed along the posterior border for osteosynthesis. We advice against removal of condylar mini plates because of the risk of nerve and salivary gland injury associated with forces required on the fibrous tissues for miniplate removal.
- From our study, we conclude that the trans-parotid approach provides an excellent direct approach to the condyle aiding in perpendicular application of osteosynthesis with least morbidity. The approach is also time saving and cost effective.
- The choice of the approach depends on factors like
    - Anatomic position of the fractured condylar process,
    - Concomitant additional jaw fractures,
    - Osteosynthesis,
    - Experience of the surgeon,
    - Possible complications and cosmetic considerations.
- Our experience suggests that the success of this procedure is closely related to the operator's experience and skill.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Malara P, Malara B, Drugacz J. Characteristics of maxillofacial injuries resulting from road traffic accidents a 5 year review of the case records from Department of Maxillofacial Surgery in Katowice, Poland. Head Face Med. 2006 Aug 28;2:27.
2. Raymond Fonseca, Robert V. Walker. Oral and Maxillofacial Trauma, second edition. Vol 1, W.B.Saunders Company.
3. Zide MF, Kent JN. Indications for open reduction of mandibular condyle fractures. J Oral Maxillofac Surg. 1983 Feb;41(2):89-98.
4. Abdel-Galil K, Loukota R. Fractures of the mandibular condyle: evidence base and current concepts of management. Br J Oral Maxillofac Surg. 2010 Oct;48(7):520-6.
5. Walker RV. Condylar fractures: nonsurgical management. J Oral Maxillofac Surg.1994 Nov;52(11):1185-8.
6. Narayanan V, Kannan R, Sreekumar K. Retromandibular approach for reduction and fixation of mandibular condylar fractures: a clinical experience. Int J Oral Maxillofac Surg. 2009 Aug;38(8):835-9.
7. Scheff J. Handbuch der Zahnheikunde. Vienna-Leipzig:Alfred Holder, 1910.
8. Silverman SL. A new operation for displaced fracture of the neck of the mandibular condyle. Dental cosmos 1925;67:876-7.
9. Steinhardt G. Die Bedeutung funktioneller Einflusse fur die Entwicklung und Formung der Kiefergenlenke, Dtsch Zahn Mund Kieferheilk 1935:1:711-5.
10. Reichenbach E. Die Verrenkungsbruche des Unterkiefergelenkkopfes. Dtsch Zahn Mund Kieferheilk. 1934;1;31-5.
11. Thoma KH. Fracture of the mandibular condyle, amethod of open reduction and internal wiring. Report of 32 cases. J Oral Surg 1945;3:3-19.

12. Davis RA, Anson BJ, Budinger JM, Kurth LR. Surgical anatomy of the facial nerve and parotid gland based upon a study of 350 cervicofacial halves. Surg Gynecol Obstet. 1956 Apr;102(4):385-412.
13. Dingman RO, Grabb WC. Surgical anatomy of the mandibular ramus of the facial nerve based on the dissection of 100 facial halves. Plast Reconstr Surg Transplant Bull. 1962 Mar;29:266-72.
14. Hinds EC, Girotti WJ. Vertical subcondylar osteotomy: a reappraisal. Oral Surg Oral Med Oral Pathol. 1967 Aug;24(2):164-70.
15. MacLennan WD. Fractures of the mandibular condylar process. Br J Oral Surg.1969 Jul;7(1):31-9.
16. Ivy RH. Post-auricular approach to mandibular condyle. Plast Reconstr Surg. 1970 Oct;46(4):390.
17. Spiessel B, Schroll K. Gelenfortsatzund gelenkkopfchenfrakturen. In:NIGST, H, ed: Spezielle Frakturen-und luxationslehre Bd.I/I:Thieme,1972.
18. Peters RA, Caldwell JB, Olsen TW. A technique for open reduction of subcondylar fractures. Oral Surg Oral Med Oral Pathol. 1976 Mar;41(3):273-80.
19. Lindahl L. Condylar fractures of the mandible. I. Classification and relation to age, occlusion, and concomitant injuries of teeth and teeth-supporting structures, and fractures of the mandibular body. Int J Oral Surg. 1977 Feb;6(1):12-21.
20. Champy M, Loddé JP, Schmitt R, Jaeger JH, Muster D. Mandibular osteosynthesis by miniature screwed plates via a buccal approach. J Maxillofac Surg. 1978 Feb;6(1):14-21.
21. Koberg WR, Momma WG. Treatment of fractures of the articular process by functional stable osteosynthesis using miniaturized dynamic compression plates. Int J Oral Surg. 1978 Aug;7(4):256-62.

22. Al-Kayat A, Bramley P. A modified pre-auricular approach to the temporomandibular joint and malar arch. Br J Oral Surg. 1979 Nov;17(2):91-103.
23. Ellis E 3rd, Moos KF, el-Attar A. Ten years of mandibular fractures: an analysis of 2,137 cases. Oral Surg Oral Med Oral Pathol. 1985 Feb;59(2):120-9.
24. Rowe and Williams. Maxillofacial injuries. Vol 1. Churchill Livingstone.
25. Kitayama S. A new method of intra-oral open reduction using a screw applied through the mandibular crest of condylar fractures. J Craniomaxillofac Surg. 1989 Jan;17(1):16-23.
26. Habel G, O'Regan B, Hidding J, Eissing A. A transcoronoidal approach of fractures of the condylar neck. J Craniomaxillofac Surg. 1990 Nov;18(8):348-51.
27. Fridrich KL, Pena-Velasco G, Olson RA. Changing trends with mandibular fractures: a review of 1,067 cases. J Oral Maxillofac Surg. 1992 Jun;50(6):586-9.
28. Silvennoinen U, Iizuka T, Lindqvist C, Oikarinen K. Different patterns of condylar fractures: an analysis of 382 patients in a 3-year period. J Oral Maxillofac Surg. 1992 Oct;50(10):1032-7.
29. Starck WJ, Catone GA, Kaltman SI. A modified endaural approach to the temporomandibular joint. J Oral Maxillofac Surg. 1993 Jan;51(1):33-7; discussion 37-8.
30. Hayward JR, Scott RF. Fractures of the mandibular condyle. J Oral Maxillofac Surg. 1993 Jan;51(1):57-61.
31. Ellis E 3rd, Dean J. Rigid fixation of mandibular condyle fractures. Oral Surg Oral Med Oral Pathol. 1993 Jul;76(1):6-15.
32. Worsaae N, Thorn JJ. Surgical versus nonsurgical treatment of unilateral dislocated low subcondylar fractures: a clinical study of 52 cases. J Ora Maxillofac Surg. 1994 Apr;52(4):353-60; discussion 360-1.

33. Gosain AK. Surgical anatomy of the facial nerve. Clin Plast Surg. 1995 Apr;22(2):241-51.

34. Widmark G, Bågenholm T, Kahnberg KE, Lindahl L. Open reduction of subcondylar fractures. A study of functional rehabilitation. Int J Oral Maxillofac Surg. 1996 Apr;25(2):107-11.

35. Chossegros C, Cheynet F, Blanc JL, Bourezak Z. Short retromandibular approach of subcondylar fractures: clinical and radiologic long-term evaluation. Oral Sur Oral Med Oral Pathol Oral Radiol Endod. 1996 Sep;82(3):248-52.

36. Anastassov GE, Rodriguez ED, Schwimmer AM, Adamo AK. Facial rhytidectomy approach for treatment of posterior mandibular fractures. J Craniomaxillofac Surg. 1997 Feb;25(1):9-14.

37. Baker AW, McMahon J, Moos KF. Current consensus on the management of fractures of the mandibular condyle. A method by questionnaire. Int J Oral Maxillofac Surg.1998 Aug;27(4):258-66.

38. Iizuka T, Lädrach K, Geering AH, Raveh J. Open reduction without fixation of dislocated condylar process fractures: long-term clinical and radiologic analysis. J Oral Maxillofac Surg. 1998 May;56(5):553-61; discussion 561-2.

39. Palmieri C, Ellis E 3rd, Throckmorton G. Mandibular motion after closed and open treatment of unilateral mandibular condylar process fractures. J Oral Maxillofac Surg. 1999 Jul;57(7):764-75; discussion 775-6.

40. Undt G, Kermer C, Rasse M, Sinko K, Ewers R. Transoral miniplate osteosynthesis of condylar neck fractures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999 Nov;88(5):534-43.

41. Choi BH, Yoo JH. Open reduction of condylar neck fractures with exposure of the facial nerve. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999 Sep;88(3):292-6.
42. Kempers KG, Quinn PD, Silverstein K. Surgical approaches to mandibular condylar fractures: a review. J Craniomaxillofac Trauma. 1999 Winter;5(4):25-30.
43. Ellis E 3rd, Simon P, Throckmorton GS. Occlusal results after open or closed treatment of fractures of the mandibular condylar process. J Oral Maxillofac Surg. 2000 Mar;58(3):260-8.
44. Ellis E 3rd, Throckmorton G. Facial symmetry after closed and open treatment of fractures of the mandibular condylar process. J Oral Maxillofac Surg. 2000 Jul;58(7):719-28; discussion 729-30.
45. Ellis E 3rd, McFadden D, Simon P, Throckmorton G. Surgical complications with open treatment of mandibular condylar process fractures. J Oral Maxillofac Surg. 2000 Sep;58(9):950-8.
46. Meyer C, Kahn JL, Boutemi P, Wilk A. Photoelastic analysis of bone deformation in the region of the mandibular condyle during mastication. J Craniomaxillofa Surg. 2002 Jun;30(3):160-9.
47. Devlin MF, Hislop WS, Carton AT. Open reduction and internal fixation of fractured mandibular condyles by a retromandibular approach: surgical morbidity and informed consent. Br J Oral Maxillofac Surg. 2002 Feb;40(1):23-5.
48. Güerrissi JO. A transparotid transcutaneous approach for internal rigid fixation in condylar fractures. J Craniofac Surg. 2002 Jul;13(4):568-71.
49. Martin S. Greenberg and Micheal Glick. Burket's Oral medicine diagnosis and treatment,tenth edition. BC Decker Inc.

50. Manisali M, Amin M, Aghabeigi B, Newman L. Retromandibular approach to the mandibular condyle: a clinical and cadaveric study. Int J Oral Maxillofac Surg. 2003 Jun;32(3):253-6.
51. Celić R, Jerolimov V, Knezović Zlatarić D, Klaić B. Measurement of mandibular movements in patients with temporomandibular disorders and in asymptomatic subjects. Coll Antropol. 2003;27 Suppl 2:43-9.
52. Brandt MT, Haug RH. Open versus closed reduction of adult mandibular condylar fractures: a review of the literature regarding the evolution of current thoughts on management. J Oral Maxillofac Surg. 2003 Nov;61(11):1324-32.
53. Loukota RA, Eckelt U, De Bont L, Rasse M. Subclassification of fractures of the condylar process of the mandible. Br J Oral Maxillofac Surg. 2005 Feb;43(1):72-3.
54. Ellis E, Throckmorton GS. Treatment of mandibular condylar process fractures: biological considerations. J Oral Maxillofac Surg. 2005 Jan;63(1):115-34.
55. Vesnaver A, Gorjanc M, Eberlinc A, Dovsak DA, Kansky AA. The periauricular transparotid approach for open reduction and internal fixation of condylar fractures. J Craniomaxillofac Surg. 2005 Jun;33(3):169-79.
56. Eckelt U, Schneider M, Erasmus F, Gerlach KL, Kuhlisch E, Loukota R, Rasse M, Schubert J, Terheyden H. Open versus closed treatment of fractures of the mandibular condylar process-a prospective randomized multi-centre study. J Craniomaxillofac Surg. 2006 Jul;34(5):306-14.
57. Schoen R, Fakler O, Metzger MC, Weyer N, Schmelzeisen R. Preliminary functional results of endoscope-assisted transoral treatment of displaced bilateral condylar mandible fractures. Int J Oral Maxillofac Surg. 2008 Feb;37(2):111-6.

58. Trost O, Abu El-Naaj I, Trouilloud P, Danino A, Malka G. High cervical transmasseteric anteroparotid approach for open reduction and internal fixation of condylar fracture. J Oral Maxillofac Surg. 2008 Jan;66(1):201-4.
59. Gerbino G, Boffano P, Tosco P, Berrone S. Long-term clinical and radiological outcomes for the surgical treatment of mandibular condylar fractures. J Oral Maxillofac Surg. 2009 May;67(5):1009-14.
60. Trost O, Trouilloud P, Malka G. Open reduction and internal fixation of low subcondylar fractures of mandible through high cervical transmasseteric anteroparotid approach. J Oral Maxillofac Surg. 2009 Nov;67(11):2446-51.
61. Downie JJ, Devlin MF, Carton AT, Hislop WS. Prospective study of morbidity associated with open reduction and internal fixation of the fractured condyle by the transparotid approach. Br J Oral Maxillofac Surg. 2009 Jul;47(5):370-3.
62. Biglioli F, Colletti G. Transmasseter approach to condylar fractures by mini-retromandibular access. J Oral Maxillofac Surg. 2009 Nov;67(11):2418-24.
63. Klatt J, Pohlenz P, Blessmann M, Blake F, Eichhorn W, Schmelzle R, Heiland M. Clinical follow-up examination of surgically treated fractures of the condylar process using the transparotid approach. J Oral Maxillofac Surg. 2010 Mar;68(3):611-7.
64. Vesnaver A, Ahčan U, Rozman J. Evaluation of surgical treatment in mandibular condyle fractures. J Craniomaxillofac Surg. 2012 Dec;40(8):647-53.
65. Yang L, Patil PM. The retromandibular transparotid approach to mandibular subcondylar fractures. Int J Oral Maxillofac Surg. 2012 Apr;41(4):494-9.
66. Girotto R, Mancini P, Balercia P. The retromandibular transparotid approach: our clinical experience. J Craniomaxillofac Surg. 2012 Jan;40(1):78-81.

67. Kim BK, Kwon YD, Ohe JY, Choi YH, Choi BJ. Usefulness of the retromandibular transparotid approach for condylar neck and condylar base fractures. J Craniofac Surg. 2012 May;23(3):712-5.
68. Colletti G, Biglioli F. Mini-retromandibular access to the condyle in panfacial fractures. J Craniofac Surg. 2012 Sep;23(5):e400-4.
69. Eric W Baker. Head and Neck Anatomy for Dental Medicine.Thieme Medical Publishers,Inc. New York.
70. Ellis EE, Zide MF, eds: Surgical approaches to the facial skeleton.Baltimore: Williams & Wilkins 1995.
71. O'Regan B, Bharadwaj G, Bhopal S, Cook V. Facial nerve morbidity after retrograde nerve dissection in parotid surgery for benign disease: a 10-year prospective observational study of 136 cases. Br J Oral Maxillofac Surg. 2007 Mar;45(2):101-7.
72. Dr.S.I.Bhalaji .Orthodontics - The Art and Science. Second Edition. ARYA (MEDI) publishing house.
73. Orban's Oral histology and embryology.15th edition. Elsevier publications.
74. Krenkel, Christian. Biomechanics and osteosynthesis of condylar neck fractures of the mandible. 1994, Quintessence publishing Co. Inc, carol stream, Illinois.
75. Bos RR, Ward Booth RP, de Bont LG. Mandibular condyle fractures: consensus. Br J Oral Maxillofac Surg. 1999 Apr;37(2):87-9.
76. Choi BH, Yi CK, Yoo JH. Clinical evaluation of 3 types of plate osteosynthesis for fixation of condylar neck fractures. J Oral Maxillofac Surg. 2001 Jul;59(7):734-7; discussion 738.
77. Loukota RA. Endoscopically assisted reduction and fixation of condylar neck/base fractures--The learning curve. Br J Oral Maxillofac Surg. 2006 Dec;44(6):480-1.

78. Tasanen A, Lamberg MA. Transosseous wiring in the treatment of condylar fractures of the mandible. J Maxillofac Surg. 1976 Dec;4(4):200-6.

ANNEXURES

Annexure I

INFORMED CONSENT

CLINICAL FOLLOWUP OF PATIENTS TREATED FOR CONDYLAR FRACTURES BY A TRANSPAROTID APPROACH

WHY DO THIS STUDY:

The purpose of this study is to evaluate the morbidity associated with the use of a transparotid approach for treatment of fractured condylar process.

WHAT WILL PARTICIPATION INVOLVE ?

The fractured condylar process will be treated by open reduction and internal fixation. Evaluation of the facial nerve weakness, movements of the jaw, scar length and other parameters described in the study will be performed at 2 weeks, 6 weeks, 3 months and at 6 month intervals.

HOW LONG WILL THE PARTICIPATION TAKE?

The entire surgical procedure will take 90 minutes. Intermaxillary fixation may be required post operatively, suture removal will be done on the 7^{th} post operative day. Post operative radiograph assessment and clinical assessment done at 2 weeks, 6 weeks, 3 months and 6 months will require 30 minutes each.

As an informed participant of this trial I understand that:

- My participation is voluntary.
- I am aware of what my participation involves.

- I have been explained about the complications involved in the surgical procedure.
- All my questions about this study and surgical procedures are answered satisfactorily.
- I also give consent for use of my clinical and surgical photographs.

I have read and understood the above and I give my consent to participate.

Participant's signature_____ Date:_____

I have explained the above and answered all questions asked by the participant

Researcher's signature_____ Date:_____

ஒப்புதல் அறிக்கை

ஆராய்ச்சியின் தலைப்பு

கீழ்த்தாடை எலும்பு முண்டில் ஏற்படும் முறிவை பரோடிட் உமிழ்நீர் சுரப்பி வாயிலாக அறுவை சிகிச்சை செய்யப்பட்ட நோயாளிகளுக்கானத் தொடர் வருகை.

ஆராய்ச்சி செய்வதன் நோக்கம்

கீழ்த்தாடையில் ஏற்படும் எலும்பு முண்டு முறிவை பரோடிட் உமிழ்நீர் சுரப்பி வாயிலாக அறுவை சிகிச்சை செய்து சரி செய்யப்பட்டதன் மூலமாக கிடைக்கும் உபயோகங்களையும் பின்விளைவுகளையும் பற்றிப் படிப்பதே இவ்வாராய்ச்சியின் நோக்கம்.

ஆராய்ச்சியில் தங்களைப் பங்கு கொள்ளச் செய்வதன் நோக்கம்

உடைந்து போன முண்டு எலும்பு இருக்கும் பகுதியை அறுவை சிகிச்சை மூலம் திறந்து உடைந்த எலும்பைத் தகடுகள் மூலம் இணைத்துத் தாடையைத் தன் இயல்பு நிலைக்குக் கொண்டு வரப்படும்.

அறுவை சிகிச்சை முடிந்த பின்னர் முகத்தோடு சம்பந்தப்பட்ட நரம்புகளின் செயல்பாடுகள் தாடையின் அசைவுகள் சிகிச்சை செய்யப்பட்ட இடத்திலுள்ள தழும்பின் அளவு மற்றும் இதர ஆய்வுகள் 2 வாரம் 6 வாரம் 3 மாதம் மற்றும் 6 மாத இடைவெளியில் நடத்தப்படும்.

ஆராய்ச்சிக்கான மொத்த கால அவகாசம்

முழுமையான அறுவை சிகிச்சை செய்வதற்கு 90 நிமிடங்கள் ஆகும். சிகிச்சைக்குப் பின்னர் தாடை அசையாதிருக்க இரு தாடைகளுக்கும் இடையே கம்பிகளால் கட்டுப் போட வேண்டிய அவசியம் ஏற்படலாம். அறுவை சிகிச்சை செய்த ஏழாவது நாளில் தையல் பிரிக்கப்படும்.

பின்னர் தகடுகள் சரியாக நிர்ணயிக்கப்பட்டுள்ளதா என்பதை உறுதி செய்யவும் எலும்புகள் சரியாக இணைக்கப்பட்டுள்ளதா என்பதை உறுதி செய்யுவும் அறுவை சிகிச்சைக்குப் பின் ஊடுகதிர்ப்படம் எடுத்துப் பரிசோதிக்கப்படும் பின்பு 2 வாரம் 6 வாரம் 3 மாதம் மற்றும் 6 மாத இடைவெளியில் இதர பரிசோதனைகள் செய்யப்படும் இப்பரிசோதனைகளுக்கு 30 நிமிடங்கள் ஆகும்.

இந்த சிகிச்சையில் பங்களிக்கும் நான்

- ➔ எனது பங்களிப்பினை பற்றி நன்கு அறிவேன்.
- ➔ எவ்வித நிர்பந்தத்திற்கும் உட்படாமல் தன்னிச்சையாகப் பங்களிப்பேன்.
- ➔ இந்த ஆய்வில் உள்ள சிக்கல்கள் குறித்துத் தெளிவாக விளக்கப்பட்டேன்.
- ➔ என்னுடைய அனைத்துக் கேள்விகளுக்கும் மற்றும் இந்த அறுவை சிகிச்சை முறையைப் பற்றியும் நான் திருப்திகரமாகப் பதிலளிக்கப்பட்டேன்.
- ➔ என்னுடைய சிகிச்சை மற்றும் புகைப்படக்குறிப்புகளை உபயோகப்படுத்த அனுமதி அளிக்கிறேன்.

நான் இந்த முயற்சியின் செய்முறைகளைப் பற்றி முழுமையாக அறிந்து கொண்டேன் மேலும் என்னுடைய குறிப்புகளை இந்நிறுவனத்திடம் வெளிப்படுத்த சம்மதிக்கிறேன்.

நோயாளியின் கையொப்பம்:_____ நாள்: _____

நான் மேற்சொன்ன அனைத்து விவரங்களையும் தெளிவாக விவரித்து பங்குப் பெறுபவரின் எல்லா கேள்விகளுக்கும் பதில் அளித்துள்ளேன்.

ஆராய்ச்சியாளரின் கையொப்பம்:_____ நாள்: _____

Annexure II

CASE HISTORY PROFORMA

Date:

Name :

Age/Sex :

Address :

Occupation :

Chief Complaint :

History of Presenting Illness :

Past Medical History :

Drug Allergy :

Past Dental History :

Family History :

Personal History :

Vital signs

- BP
- Pulse
- Respiratory rate
- Temperature
- Weight

General examination

- Jaundice
- Anaemia
- Clubbing
- Cyanosis
- Lymphadenopathy
- Oedema

Extra Oral Examination

- Facial asymmetry
- Mouth opening
- Deviation on mouth opening
- Swelling, tenderness

Intra-Oral Examination

- Soft tissue examination

Systemic Examination:

- CNS
- CVS
- RS
- GIT

- Hard tissue examination
- Occlusion

Provisional Diagnosis

Investigations

Final Diagnosis

Treatment Plan

Annexure III

Functional outcome after trans-parotid approach: **Patient data form**

NAME :

AGE/SEX :

ASSOCIATED INJURIES :

DURATION OF SURGERY (min) :

TYPE OF OSTEOSYNTHESIS :

SALIVARY FISTULA :

WOUND INFECTION :

IMF/ELASTICS :

SCAR LENGTH (mm) :

PERMANANT DEFLECTION :

PARAMETERS	Facial nerve weakness	Mandibular function(mm)			Fracture of osteosynthetic plate	Mouth opening(mm)	Pain on function score
		P*	MF*	MNF*			
2 week							
6 weeks							
3 months							
6 months							

P* - Protrusion

MF* - Mediotrusion on fractured side

MNF*- Mediotrusion on non fractured side

Annexure IV

House–Brackmann grading[71]

Grade	Description	Appearance	Movement			
		Gross	At rest	Forehead	Eye	Mouth
I	Normal	Normal	Normal	Normal	Normal	Normal
II	Mild dysfunction	Slight weakness noticed on close inspection.	Normal symmetry and tone	Moderate to good function	Complete closure with minimal effort	Slight asymmetry
III	Moderate dysfunction	Obvious but not disfiguring difference between two sides. noticeable but not severe synkinesis, contracture or hemifacial spasm.	Normal symmetry and tone	Slight to moderate movement	Complete closure with effort	Slightly weak with maximal effort
IV	Moderately severe dysfunction	Obvious weakness and disfiguring asymmetry.	Normal symmetry and tone	None	Incomplete closure	Asymmetry with maximal effort
V	Severe dysfunction	Only barely perceptible movement.	Asymmetry	None	Incomplete closure	Slight movement
VI	Total paralysis	No movement	No movement	None	None	none

Annexure V

Numeric visual analog scale[49]