SURGERY INSIGHTS

MIDITERRANEAN JOURNALS

Review

DOI: 10.55085/si.2022.653

Condyle Dislocation to Medial Cranial Fossa: A Systematic Review

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ABSTRACT

Purpose: This study aims to investigate the clinical, immunological complications and their relations to each one of the treatment approaches for the traumatic dislocation of the mandibular condyle to the medial cranial fossa.

Methods: An electronic literature search was undertaken in June/2021. Eligibility criteria included publications having enough clinical, radiological, treatment protocols, and post-operative outcomes information.

Results: 46 publications (50 patients) were included. Most of the patients were women (70%), the most common age range in the pediatric population from 0 to 15 years old (34%). The mean age is 25,66 years old (+- 15,19). The most common causes are automotive accidents (60%), Falls (8%), and Assaults (8%), followed by one case of an industrial accident. Otorrhagia was present in 10% of the patients, loss of conciseness in 10% of the patients, followed by 6% presenting intracranial hematoma. Open treatment was preferred by 44%, followed by closed treatment (26%), condylectomy (16%), and conservative treatment (14%). No complications were observed in 60% of the patients. However, complications related to the TMJ were observed in 38% of the cases, followed by 2% of complications related to the medial cranial fossa. Comparative statistical analyzes did not show differences between the treatment modalities as the complications, except when compared with closed treatment with complications related to the medial cranial fossa (p = 0,035).

Conclusions: The traumatic dislocation of the mandibular condyle to the medial cranial fossa is a rare complication related to facial trauma, with only fifty cases described in the literature. The treatment modalities did not influence the development of complications, except when the chosen treatment is the closed one when the odds for complications related to the medial cranial fossa are slightly higher.

Keywords: Neurologic Trauma, Oral and Maxillofacial Surgery, Trauma.

Received: 09 Mar 2022
Revised: 26 Mar 2022
Accepted: 12 Apr 2022
Published: 18 Apr 2022

Academic Editor:
Mohammad Waheed El-Anwar

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Cite this article as: Costa SM, Ribeir BC, Amaral MB. Condyle Dislocation to Medial Cranial Fossa: A Systematic Review. Surg Insights. 2022;1:653. [https://doi.org/10.55085/si.2022.653]

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Authors' contributions
The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript, and provided approval for this final revised version.

Acknowledgments
None.

Funding
No funding was received from any organization to conduct the present study.

Conflict of interest
The authors declare that there is no conflict of interest regarding the publication of this article.

1. INTRODUCTION

Mandibular condyle (MC) fractures are usually common, representing 27 to 43% of all mandibular fractures. (He et al., 2007; Rashid et al.,2013; Zix et al., 2011; Bormann et al., 2009). This expressive number is motivated by the safety mechanism of the condylar neck weakness, which protects the cranial base from more severe trauma to the mandibular bone. The traumatic dislocation of the mandibular condyle to the medial cranial fossa (TD) is a rare event. It's related to the failure or the absence of these "safety mechanisms" that include the propensity of the thin condylar neck to fracture under sufficient force preventing the intact MC to fracture the glenoid fossa from entering the middle cranial fossa. (Tutela et al., 2013) The present study aimed to integrate the available data published in the literature on TD into an updated, comprehensive comparative analysis of their clinical, immunological features and investigate the complications and their relations to each of the treatment approaches.

2. METHODS

The authors designed a systematic review modeled after the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement and the Cochrane Collaboration's recommendations for systematic reviews to address the research purpose. (Higgins, 2011) A review protocol does not exist.

In accordance with the PRISMA statement for systematic reviews, the following focus question of the research was established: What are the clinical and immunological parameters, the proposed treatment, and the most common complications for the traumatic dislocation of the mandibular condyle to the middle cranial fossa?

The inclusion criteria were all studies published on the topic of traumatic dislocation of the mandibular condyle to the middle cranial fossa without time limitation until June 2019. The study should contain information about the patient's gender, age, etiology of the trauma, symptoms details, imaging information, type of treatment, and complications on the follow-up.

2.1. Study Design

This study is a systematic review, and the sample was composed of all publications. The electronic database search was performed in MEDLINE (PubMed), SCOPUS, and the Cochrane Library. The final search was performed on June 30, 2021. The search terms used were mandibular condyle, fracture, condyle dislocation, condyle luxation, medial cranial fossa, and complications. Detailed search strategies were developed for each database (Table 01). Additional manual search also was conducted based on the reference list of all included studies and in the most cited journals on the topic, including the British Journal of Oral and Maxillofacial Surgery, International Journal of Oral and Maxillofacial Surgery, Japanese Journal of Oral and Maxillofacial Surgery, Journal of Craniofacial Surgery, Journal of Cranio-Maxillofacial Surgery, Journal of Maxillofacial and Oral Surgery, Journal of Oral and Maxillofacial Surgery, Oral Surgery Oral Medicine Oral Pathology Oral Radiology, Otolaryngology, Head and Neck Surgery. Publications with diagnosis identified by other authors as TD, even not having the terms "mandibular condyle, fracture, condyle dislocation, condyle luxation, medial cranial fossa, complications" in the article's title were also re-evaluated by an author of the present study.

2.2. Variables

Number of patients
Gender distribution
Etiology
CSF Leak
Otorrhagia
Loss of consciousness
Intracranial hematoma
X-Ray examination
CT Scan
MRI
Treatment
Complications

2.3. Data Collection Methods

For the initial selection, two independent reviewers analyzed the title and abstract of all searched studies, which were subjected to the inclusion and exclusion criteria established before the beginning of the study. Randomized and controlled clinical trials, cohort studies, case-control studies, cross-sectional studies, case series, and case reports were included. Exclusion criteria were excluded from radiological studies, conference abstracts, editorials, poorly described cases, review articles, or case series without primary data or where the analysis was pooled without a description of individual patient data.

After determining the included studies, the two researchers collected and tabulated data using Numbers (Apple Inc, Cupertino, CA, USA), and the results were analyzed, the duplicates were removed, and the two independent reviews evaluated the titles and abstracts. In case of divergence, two expert researchers were consulted. By the end, the four examiners read the full text of the studies and determined the final inclusion of the studies in the systematic review using the same calibrated selection criteria.

2.4. Data Analysis

The authors independently extracted data using specially designed data extraction forms. The following data were extracted: author, year of publication, number and gender of the patients, age and mean age, etiology, symptoms, image protocol, treatment, and complications during follow-up. The extracted data were subjected to descriptive analysis.

2.5. Analysis

The mean, standard deviation (SD), and percentages were presented as descriptive statistics. Kolmogorov–Smirnov test was performed to evaluate the normal distribution of the variables. The Wilcoxon rank test was used to relate. The degree of statistical significance was considered $p < 0.05$. All data were statistically analyzed using the IBM SPSS 23 (IBM, Armonk, New York, USA).

3. RESULTS

3.1. Literature search

The electronic search was conducted on June 30, 2019, and 118 studies were retrieved. Titles and abstracts were read, and 29 studies were included according to the previously described criteria. Fifty - three studies were excluded after the abstract analysis, and fourteen were excluded after the full-text critical essay because they did not meet one of the inclusion criteria. Figure 01 presents the flowchart of the systematic review process. All the data is reunited in Table 01 and Table 02.

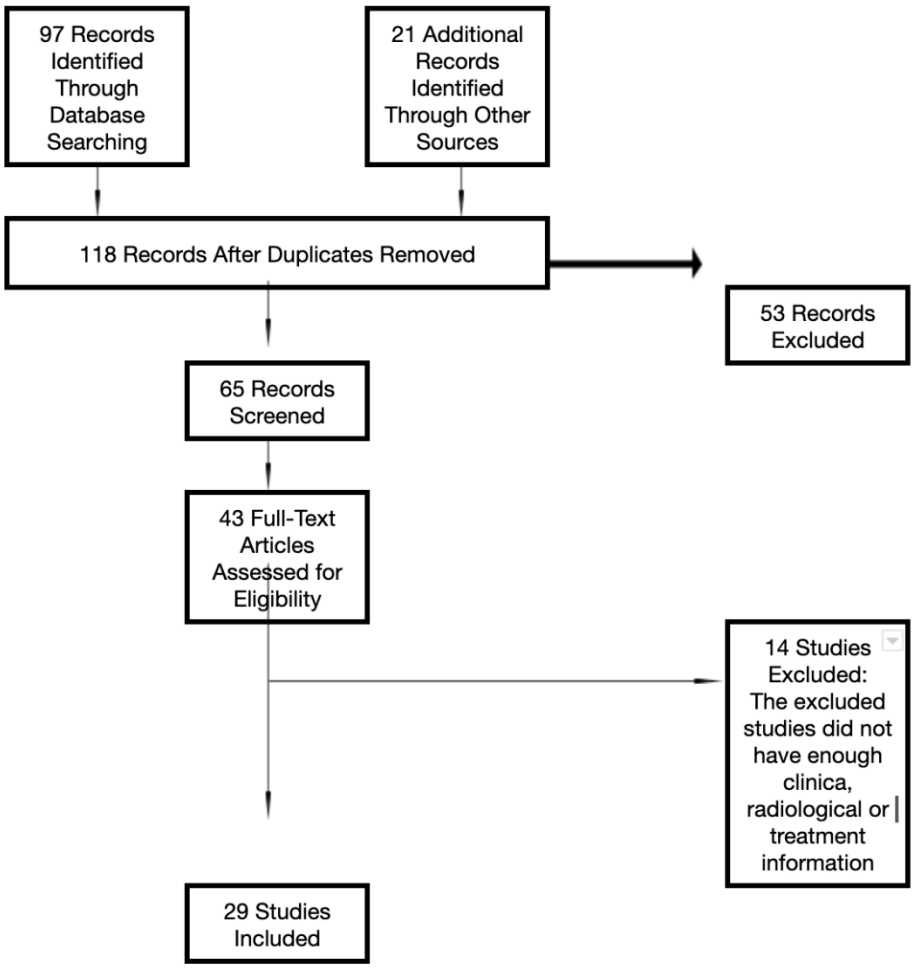

Figure 1: the flowchart of the systematic review process.

Description of the Studies and Analyses

Some studies reporting a series of MC fractures and including TD were found. Still, their cases were not included here due to a lack of clinical, immunological information to confirm the diagnosis. These include, for example, Belli et al. (Belli et al., 2015).

Table 1 presents demographic and clinical features of all 50 TD reported in 46 publications (Heidsieck, 1960; Dingman & Grabb, 1963; Doane, 1963; Steinhauser, 1964; Stoltmann, 1965; Cernea et al., 1965; Dechaume & Grellet, 1965; Peltier & Mathews, 1965; Whiteacre, 1966; Brons, 1967; Rowe & Killey, 1968; Pirok & Merril, 1970; Lund, 1971; Seymour & Irby, 1976; Pons et al., 1976; Zecha, 1977; Kallal, Gans & Lagrotteria, 1977; Pieritz, 1980; Ihalainen & Tanasen, 1983; Pepper & Zide, 1985; Copenhaver et al., 1985; Musgrove, 1986; Paulette et al., 1989; Engevall & Fischer, 1992; Chuong, 1994; Dahlberg et al., 1995; Tornes & Lind, 1995; Melugin et al., 1997; Long et al., 1997; Barron et al., 2002; Van der Linden, 2003; Harstall, Gratz & Zahlen, 2005; Clausen et al., 2006; Ohura et al., 2006; Rosa, Guimaraes & Marie, 2006; Magge et al., 2007; Tagliatela Scafati et al., 2008; Man et al.,

2010; Vasconcelos, Rocha & Cypriano, 2010; Struewe et al., 2012; Tutela et al., 2013; Zhang et al., 2014, Oberman, Setabutr & Goldenberg, 2014; He et al., 2015; De Mol et al., 2017; Chen et al., 2018).

3.2. Description of the studies included

Six studies used conservative treatment only (Heidsieck, 1960; Dingman & Grabb, 1963; Peltier & Mathews, 1965; Brons, 1967; Lund, 1971; Rosa, Guimarães & Marie, 2006; De Mol et al., 2017).

The closed reduction was the option in thirteen studies (Steinhauser, 1964; Pirok & Merrill, 1970; Zeche, 1970; Kallal, Gans & Lagrotteria, 1977; Piertiz, 1980; Ihalainen & Tanasen, 1983; Musgrove, 1986; Pauletter et al., 1989; Harstall, Gratz & Zahlen, 2005; Vasconcelos, Rocha & Cypriano, 2010; Tutela et al., 2013; Oberman, Setabutr & Goldenberg, 2014; He et al., 2015).

Nineteen studies preferred the open treatment and reduction under direct vision (Doane, 1963; Stoltman, 1965; Whiteacre, 1966; Rowe & Killey, 1968; Pons et al., 1976; Pepper & Zide, 1985; Copenhaver et al., 1985; Engevall & Fischer, 1992; Dahlberg et al., 1995; Melugin et al., 1997; Long et al., 1997; Barron et al., 2002; Van der Linden et al., 2003; Ohura et al., 2006; Magge et al., 2007; Struewer et al., 2012; Zhang et al., 2014; He et al., 2015; Chen et al., 2018).

Eight studies used the condylectomy as the first option treatment(Cernea et al., 1965; Dechaume & Grellet, 1965; Seymour & Irby, 1976; Chuong, 1994; Tornes & Lind, 1995; Clauser et al., 2006; Tagliatela Scafati et al., 2008; Man et al., 2010).

3.3. Results of the outcome variables

Complications related to the TMJ (CTMJ) and complications related to the medial cranial fossa(CMCF).

3.3.1. Conservative Treatment

A total of six patients were enrolled in this study, treated with conservative treatment only (Heidsieck, 1960; Dingman & Grabb, 1963; Peltier & Mathews, 1965; Brons, 1967; Lund, 1971; Rosa, Guimaraes & Marie, 2006; De Mol et al., 2017). The rate of CTMJ was 50% (3/6), and the rate of CMCF was 16,66% (1/6).

3.3.2. Closed Treatment

A total of thirteen patients were treated with a closed treatment (Steinhauser, 1964; Pirok & Merril, 1970; Zeche, 1970; Kallal, Gans & Lagrotteria, 1977; Piertiz, 1980; Ihalainen & Tanasen, 1983; Musgrove, 1986; Pauletter et al., 1989; Harstall, Gratz & Zahlen, 2005; Vasconcelos, Rocha & Cypriano, 2010; Tutela et al., 2013; Oberman, Setabutr & Goldenberg, 2014; He et al., 2015). The rate of CTMJ was 15,38% (2/13), the rate of CMCF was 7,69% (1/13).

3.3.3. Open Treatment

A total of nineteen patients were treated with open treatment and reduction under direct vision (Doane, 1963; Stoltman, 1965; Whiteacre, 1966; Rowe & Killey, 1968; Pons et al., 1976; Pepper & Zide, 1985; Copenhaver et al., 1985; Engevall & Fischer, 1992; Dahlberg et al., 1995; Melugin et al., 1997; Long et al., 1997; Barron et al., 2002; Van der Linden et al., 2003; Ohura et al., 2006; Magge et al., 2007; Struewer et al., 2012; Zhang et al., 2014; He et al., 2015; Chen et al., 2018). The rate of CTMJ was 42% (8/19), and the rate of CMCF was 5,2% (1/19).

3.3.4. Condylectomy

A total of eight studies used the condylectomy as the first option treatment (Cernea et al., 1965; Dechaume & Grellet, 1965; Seymour & Irby, 1976; Chuong, 1994; Tornes & Lind, 1995; Clauser et al., 2006; Tagliatela Scafati et al., 2008; Man et al., 2010). The rate of CTMJ was 25% (2/8), and the rate of CMCF was 12,5% (1/8).

4. DISCUSSION

The purpose of this study is to review the patterns of the TD, its clinical, immunological, and treatment features, and follow-up directives.

The traumatic dislocation of the mandibular condyle to the medial cranial fossa was first described in the literature in 1960 by Heidsieck and is a rare condition related to the failure of the physiological safety mechanism. The anatomy of the condyle may explain the mechanism, as a small, rounded-like morphology has a greater possibility of breaking the cavity and entering the middle fossa of the skull, as described by He et al. 2015 and da Fonseca, 1974.

Other theories for error in the safety mechanism are the weakness of the glenoid fossa, increased pneumatization of the temporal bone, or absence of the posterior occlusion. (Zhang et al., 2014; Tsunoda et al, 2007; Rosa et al., 2006; Melugin et al., 1997).

In total, 50 patients suffered condyle dislocation to the medial cranial fossa. Most of them were women (70%), the most common age range is in the pediatric population from 0 to 15 years of age (34%), followed by the 16-30 and 31-50 population (30%). The less common

population are the 51-70 and the > 70 years old with 4% and 2% respectively. The mean age is 25,66 years old (+- 15,19). The most common causes are automotive accidents (60%), Falls (8%), and Assaults (8%), followed by one case of an industrial accident.

In the symptoms category, the CSF leak by the auditory canal was not seen in any patient. The otorrhagia was present in 10% of the patients. The included studies described the loss of conciseness in 10% of the patients, followed by 6% of the patients presenting intracranial hematoma.

The imaging protocol was mandatory in this systematic review. The X-ray was preconized in 52% of the studies, the CT Scan was preferred in 54% of the cases, and the MRI was used for only 8% of the patients. A few cases are described in the literature after the advent of tomography. The data may be slightly distorted in favor of the use of plain radiographs. However, the CT Scan is the first choice for the examination and diagnosis of the traumatic dislocation of the mandibular condyle to the medial cranial fossa, especially in the coronal view. (He et al., 2015)

The most preconized treatment for the dislocation of the mandibular condyle to the medial cranial fossa described in this systematic review is the open treatment with 44%, followed by the closed treatment (26%), condylectomy (16%), and the conservative treatment (14%). Closed reductions are less invasive and suitable for the early treatment of patients. (Koretsch et al., 2001) Open reduction can achieve the correct fracture reduction and allow the surgical team to reconstruct the glenoid fossa. However, it's a more invasive procedure and requires the cooperation of maxillofacial surgery and the neurosurgical team. He et al. suggest that this procedure is well-indicated for cases where closed reduction has failed or the MC is deeply impaled in the cranial fossa.

The condylectomy procedure is based on a similar indication for surgical treatment for TMJ ankylosis. This method avoids neurological complications but affects joint function. He et al. propose that this method should be preconized for delayed or sequelae treatment, in which there is extensive adhesion between the MC and the skull base.

No complications were observed in 60% of the patients. However, complications related to the TMJ were observed in 38% of the cases, followed by 2% of complications related to the medial cranial fossa.

Comparative statistical analyzes did not show differences between the treatment modalities as the complications, except when compared with closed treatment in relation to complications related to the medial cranial fossa ($p = 0,035$).

The results of the present study have to be interpreted with caution of its limitations. First, all included studies were case reports or case series, which inherently results in flaws manifested by the gaps in information and incomplete records. Second, many of the cases have a short follow-up, which could have led to an underestimation of the complications, especially TMJ ankylosis.

Table 1: All Described Cases of Condyle Dislocation to the Medial Cranial Fossa.

Author & Year	Number of Cases	Age	Gender	Etiology of Trauma	CSF Leak	Otorragia	Loss of Consciousness	Intracranial Hematoma	X-Ray Examination	CT Scan	MRI	Treatment	Complications
Heidsieck, 1960	1	38	NA	NA	N	N	Y	N	NA	NA	NA	Conservative	None
Dingman & Grabb, 1963	1	28	Female	Automotive Accident	N	N	N	N	Y	N	N	Conservative	None
Doane, 1963	1	13	Female	Automotive Accident	N	N	Y	N	Y	N	N	Surgical Removal Under Direct Vision	Restriction of Mandibular Movements
Steinhauser, 1964	1	26	Female	NA	N	N	N	N	NA	NA	NA	Intermaxillary Fixation	None

Stoltmann, 1965	1	25	Male	NA	N	N	Y	N	Y	N	N	Surgical Removal Under Direct Vision	None
	2	25	Male	Automotive Accident	N	N	N	N	Y	N	N	Surgical Removal Under Direct Vision	None
Cernea et al., 1965	1	13	Male	NA	N	N	N	N	NA	NA	NA	Surgical Removal Under Direct Vision + Condylectomy + Intermaxillary Fixation	Laterognathism
Dechaume & Grellet, 1965	1	33	Nale	NA	N	N	N	N	NA	NA	NA	Condyle was Osteotomized and Left in the Middle Cranial Fossa + Ibtermaxillary Fixation	Laterognathism
Peltier & Mathews, 1965	1	18	Female	Automotive Accident	N	N	N	N	Y	N	N	Conservative	Restriction of Mandibular Movements
Whiteacre, 1966	1	15	Female	Automotive Accident	N	N	N	N	Y	N	N	Surgical Removal Under Direct Vision	Restriction of Mandibular Movements
Brons, 1967	1	40	NA	NA	N	N	N	N	NA	NA	NA	New Dental Prosthesis	TMJ Dysfunction + Laterognathism
Rowe & Killey, 1968	1	50	Male	Automotive Accident	N	N	Y	N	Y	N	N	Surgical Removal Under Direct Vision + Intermaxillary Fixation	None
Pirok & Merril, 1970	1	50	Female	Industrial Accident	N	N	N	N	Y	N	N	Intermaxillary Fixation	None
Lund, 1971	1	56	Female	NA	N	N	N	N	NA	NA	NA	New Dental Prosthesis	TMJ Dysfunction

Seymour & Irby, 1976	1	64	Male	NA	N	N	N	N	NA	NA	NA	Condyle was Osteotomized and Left in the Middle Cranial Fossa + Ibtermaxillary Fixation	None
Pons et al., 1976	1	26	NA	NA	N	N	N	N	NA	NA	NA	Surgical Removal Under Direct Vision + Intermaxillary Fixation	Laterognathism
Zecha, 1977	1	25	Female	Automotive Accident	N	N	N	N	Y	N	N	Clsoed Reduction + Intermaxillary Fixation	None
Kallal, Gans & Lagrotteria, 1977	1	15	Female	Automotive Accident	N	N	N	N	Y	N	N	Clsoed Reduction + Intermaxillary Fixation	None
Pieritz, 1980	1	18	NA	NA	N	N	N	N	NA	NA	NA	Clsoed Reduction + Intermaxillary Fixation	None
Ihalainen & Tanasen, 1983	1	11	Female	Automotive Accident	N	N	N	N	Y	N	N	Closed Reduction	Restriction of Mandibular Movements
Pepper & Zide, 1985	1	32	Female	Automotive Accident	N	N	N	N	Y	Y	N	Surgical Removal Under Direct Vision + Condyle Graft to Reconstruct the Glenoid Fossa	None
Copenhaver et al., 1985	1	9	Female	Automotive Accident	N	N	N	Y	Y	Y	N	Surgical Removal Under Direct Vision + Intermaxillary Fixation	None

Musgrove, 1986	1	7	Female	Automotive Accident	N	N	N	N	Y	N	N	Clsoed Reduction + Intermaxillary Fixation	None
Paulette et al., 1989	1	11	Female	Automotive Accident	N	N	N	N	Y	Y	N	Clsoed Reduction + Intermaxillary Fixation	Restriction of Mandibular Movements
Engeval & Fischer, 1992	1	37	Female	Automotive Accident	N	N	N	N	Y	N	N	Intermaxillary Fixation + Surgical Removal Under Direct Vision+ Plate Fixation on the Zygomatic Arch to Achieve Pseudoarthrosis	TMJ Dysfunction
Chuong, 1994	1	28	Female	Automotive Accident	N	Y	N	N	Y	Y	N	Surgical Removal Under Direct Vision + Condylectomy + Intermaxillary Fixation	Diminished Hearing
Dahlberg et al., 1995	1	11	Female	Automotive Accident	N	N	N	Y	Y	Y	N	Surgical Removal Under Direct Vision	Facial Assymetry
Tornes & Lind, 1995	1	37	Female	Automotive Accident	N	Y	N	N	Y	Y	N	Condyle was Osteotomized Ibtermaxillary Fixation	None
Melugin et al., 1997	1	37	Female	Automotive Accident	N	N	N	N	N	Y	N	Glenoid Fossa and TMJ Reconstruction with Femoral Head Cartilage Graft	Restriction of Mandibular Movements

Long et al.,1997	1	38	Female	Automotive Accident	N	Y	N	N	Y	N	N	Surgical Removal Under Direct Vision	None
Barron et al.,2002	1	8	Female	Automotive Accident	N	N	N	N	Y	Y	N	Surgical Removal Under Direct Vision + Intermaxillary Fixation	None
Van der Linden, 2003	1	17	Male	Automotive Accident	N	N	N	N	Y	Y	N	Surgical Removal Under Direct Vision + Temporal Muscle Fascia Flap + Intermaxillary Fixation	Ankylosis
Harstall , Gratz & Zahlen, 2005	1	9	Female	Fall	N	N	N	N	N	Y	N	Clsoed Reduction + Intermaxillary Fixation	Facial Assymetry
Clauser et al., 2006	1	32	Female	Automotive Accident	N	N	N	N	N	Y	Y	Condyle was Osteotomized and Left in the Middle Cranial Fossa	None
Ohura et al.,2006	1	23	Female	Fall	N	N	Y	N	N	Y	Y	Surgical Removal Under Direct Vision + Temporal Muscle Fascia Flap + Intermaxillary Fixation	None
Rosa, Guimaraes & Marie, 2006	1	5	Female	Automotive Accident	N	N	N	N	N	Y	Y	Conservative	Facial Assymetry
Magge et al.,2007	1	12	Female	Playing Activities	N	N	N	N	N	Y	N	Surgical Removal Under Direct Vision + Intermaxillary Fixation	TMJ Dysfunction

Taglialatela Scafati et al.,2008	1	10	Female	Automotive Accident	N	N	NA	N	Y	Y	Y	Surgical Removal Under Direct Vision + Condylectomy + Temporal Muscle Fascia Flap	NA
Man et al., 2010	1	32	Female	Automotive Accident	N	Y	N	N	N	Y	N	Surgical Removal Under Direct Vision + Condylectomy + Temporal Muscle Fascia Flap + Intermaxillary Fixation	None
Vasconcelos, Rocha & Cypriano, 2010	1	30	Male	Assault	N	Y	N	N	Y	Y	N	Closed Reduction	None
Struewer e al., 2012	1	36	Male	Assault	N	N	N	Y	N	Y	N	Surgical Removal Under Direct Vision + Temporal Muscle Fascia Flap + Osteosynthesis of the condylar fractures	None
Tutela et al., 2013	1	72	Female	Fall	N	N	N	N	N	Y	N	Clsoed Reduction + External Fixation	None
Zhang et al., 2014	1	23	Female	Automotive Accident	N	N	N	N	N	Y	N	Surgical Removal Under Direct Vision + Calvarian bone Graft to Reconstruct the Glenoid Fossa	None

	2	39	Male	Assault	N	N	N	N	N	Y	N	Surgical Removal Under Direct Vision + Titanium Mesh to reconstruct the Glenoid fossa+ ntermaxillary Fixation	None
Oberman, Setabutr & Goldenberg, 2014	1	10	Female	Automotive Accident	N	N	N	N	N	Y	N	Clsoed Reduction + Intermaxillary Fixation	None
	1	13	Female	Fall	N	N	N	N	N	Y	N	Clsoed Reduction + Intermaxillary Fixation	None
He et al., 2015	2	25	Female	Automotive Accident	N	N	N	N	N	Y	N	Surgical Removal Under Direct Vision + Temporal Bone Graft to Reconstruct the Glenoid Fossa+ Intermaxillary Fixation	None
	3	22	Female	Automotive Accident	N	N	N	N	N	Y	N	Surgical Removal Under Direct Vision + Temporal Bone Graft to Reconstruct the Glenoid Fossa+ Intermaxillary Fixation	Restriction of Mandibular Movements
De Mol et al., 2017	1	9 (Diagnosed ate 63)	Female	NA	N	N	N	N	Y	Y	N	Conservative	None

Chen et al., 2018	1	20	Male	Automotive Accident	N	N	N	N	Y	Y	N	Surgical Removal Under Direct Vision + Intermaxillary Fixation	None
Total	50 Cases	25,66(from 5 to 72)	Male (30%) Female (70%	Automotive Accident - 60% Fall - 8% Assault - 8%) Industrial Accident - 2% NA - 22%	No- 100%	Yes - 10% No - 90%	Yes - 10% No - 88% NA - 2%	Yes - 6% No - 94%	Yes - 52% No - 30% NA - 18%	Yes - 54% No - 28% NA - 18%	Yes- 8% No - 74% NA - 18%	Intermaxillary Fixation - 22% Surgical Removal + Graft Reconstruction + Intermaxillary Fixation - 18% Condilectomy + Intermaxillary Fixation - 14% Surgical Removal Under Direct vision - 12% Surgical Removal + Intermaxillary Fixation - 12% Conservative- 8% Closed Reduction - 4% New Prosthesis - 4% Surgical Removal + Fixation 4% Closed Reduction - 4% Closed Reduction + External Fixation - 2%	Restriction of Mandibular Movements - 14% TMJ Dysfunction - 8% Facial Assymetry - 6% Laterognathism - 6% Anjylosis - 2% TMJ Dysfunction + Laterognathism - 2% None - 30%

Table 2: Descriptive Data Retrieved from the Included Studies.

Variables	Patients, n (%)	Range (Years)	Median	Mean (SD)
Age (yr)	50	5 to 72	29	25,66 (+-15,19)
0-15	17(34%)	5 to 15	11	10,41 (+- 3,02)
16-30	15(30%)	16 to 30=	25	23,4 (+- 3,79)

31-50	15(30%)	31 to 50	37	37,4(+- 5,92)
51-70	2 (4%)	56 to 64	-	60(+-5,65)
>70	1(2%)	-	-	72
Gender	50			
Male	11(22%)	13 to 64	30	32(+- 14,98)
Female	35(70%)	5 to 72	23	23,87(+- 14,95)
NA	4 (8%)	-	-	-
Etiology				
Automotive Accident	30(60%)	-	-	-
Fall	4 (8%)	-	-	-
Assault	4 (8%)	-	-	-
Industrial Accident	1(2%)	-	-	-
NA	11(22%)	-	-	-
Symptoms				
CSF Leak				
Yes	0 (0%)	-	-	-
No	50 (100%)	-	-	-
Otorragia				
Yes	5 (10%)	-	-	-
No	45(90%)	-	-	-
Loss Of Consciousness				
Yes	5 (10%)	-	-	-
No	44(88%)	-	-	-
NA	1(2%)	-	-	-
Intracranial Hematoma				
Yes	3(6%)	-	-	-
No	47(84%)	-	-	-
Image Protocol				
X-ray				
Yes	26(52%)	-	-	-
No	15(30%)	-	-	-
NA	9(18%)	-	-	-
CT Scan				
Yes	27(54%)	-	-	-
No	14(28%)	-	-	-
NA	9(18%)	-	-	-
MRI				
Yes	4(8%)	-	-	-
No	37(74%)	-	-	-
NA	9(18%)	-	-	-
Treatment				
Conservative	4(8%)	-	-	-
Closed Reduction	2(4%)	-	-	-
Closed Reduction + External Fixation	1(2%)	-	-	-
New Prosthesis	2(4%)	-	-	-
Intermaxillary Fixation	11(22%)	-	-	-
Surgical Removal Under Direct Vision	6(12%)	-	-	-

Surgical Removal + Intermaxillary Fixation	6(12%)	-	-	-
Surgical Removal+ Graft + Intermaxillary Fixation	9(18%)	-	-	-
Surgical Removal + Fixation	2(4%)	-	-	-
Condylectomy + Intermaxillary Fixation	7(14%)	-	-	-
Complications				
Laterognathim	3(6%)	-	-	-
Restriction of Mandibular Movements	7(14%)	-	-	-
TMJ Dysfunction	4 (8%)	-	-	-
Diminished Hearing	1(2%)	-	-	-
Facial Asymmetry	3(6%)	-	-	-
Ankylosis	1(2%)	-	-	-
TMJ Dysfunction+ Laterognathims	1(2%)			
None	30(60%)	-	-	-

5. CONCLUSION

The TD is a rare complication related to facial trauma, with only fifty cases described in the literature. This condition is strongly related to female patients with small-rounded mandibular condyles. The treatment modalities did not influence the development of complications, except when the chosen treatment is the closed one when the odds for complications related to the medial cranial fossa are slightly higher.

REFERENCES

[1] He Y, Zhang Y, Li Z-L ., An J-G ., Yi Z-Q ., Bao S-D. Treatment of traumatic dislocation of the mandibular condyle into the cranial fossa: development of a probable treatment algorithm. Int J Oral Maxillofac Surg. 2015;44(7):864–70. DOI: 10.1016/j.ijom.2014.12.016

[2] Rashid A, Eyeson J, Haider D, van Gijn D, Fan K. Incidence and patterns of mandibular fractures during a 5-year period in a London teaching hospital. Br J Oral Maxillofac Surg. 2013;51(8):794–8. DOI: 10.1016/j.bjoms.2013.04.007

[3] Zix J, Schaller B, Lieger O, Saulacic N, Thoren H, Iizuka T. Incidence, aetiology and pattern of mandibular fractures in central Switzerland. Swiss Med Wkly. 2011;141. DOI: 10.4414/smw.2011.13207

[4] Bormann K-H, Wild S, Gellrich N-C, Kokemüller H, Stühmer C, Schmelzeisen R, et al. Five-Year Retrospective Study of Mandibular Fractures in Freiburg, Germany: Incidence, Etiology, Treatment, and Complications. J Oral Maxillofac Surg. 2009;67(6):1251–5. DOI: 10.1016/j.joms.2008.09.022

[5] Tutela JP, Verbist DE, Kelishadi S, Little JA. Traumatic Dislocation of the Mandibular Condyle Into the Middle Cranial Fossa in an Elderly Patient. J Craniofac Surg. 2013;24(5):1703–5. DOI: 10.1097/scs.0b013e31828a76b1

[6] Higgins J, Green S. Cochrane Handbook for Systematic Reviews of Interventions. 2011.

[7] Heidsieck C. Beitrag zur sogenanntenzentralen Kiefergelenks- luxation, in: Schuchardt K (ed): Fortschritte der Kiefer- und Gesichts-Chirurgie. 1960;105–8.

[8] Doane HF. Dislocation of the Right Mandibular Condyle into the Middle Cranial Fossa. J Oral Surg. 1963;21:511–4. Available from: https://pubmed.ncbi.nlm.nih.gov/14075486/

[9] Steinhauser E. Zur zentralen Kiefergelenskslyxation in die mittlere Schadelgrube anhand eines Falles. 1964;41:26.

[10] Stoltmann H. Fracture disclocation of the temperomandibular joint. Journal Neurosurgery. 1965;22:100.

[11] Cernea P, Crrpy C, Mazza R. Fracture Enfoncement de la cavit glenoide du temporal revele par une ankylose tem-poro-maxillaire. 1965;66:65.

[12] Dechaume M, Grellet M. Un cas d'ankylose par enfoncement de la cavité glenoide. 1965;66(58).

[13] Peltier J, Mathews T. Mandibular Condyle in Middle Cranial Fossa: Report of a Case. 1965;23: 74-77

[14] Whitacre WB. Dislocation of the mandibular condyle into the middle cranial fossa: review of the literature and report of a case. Plast Reconstr Surg. 1966;38(1):23–6. DOI: 10.1097/00006534-196607000-00004

[15] Brons DR. Fractuur van fossa mandibularis,met dislokatie van processus articularis mandibulae naar middelste schedel- groeve. Ned Tijdschr Geneeskd. 1967; 111:490

[16] Rowe RO, Killey HC. Fractures of the Facial Skeleton. Williams and Wilkins. 1968
[17] Pirok DJ, Merrill RG. Dislocation of the mandibular condyle into the middle cranial fossa. Oral Surgery. 1970;13-19
[18] Lund K. Central luksation i kaebeleddet. Tandlaegebladet. 1971;75:803
[19] Seymour RL, Irby WB. Dislocation of the condyle into the middle cranial fossa: review of the literature and report of a case. Plastic and Reconstructive Surgery. 1966;38:23
[20] Pons J, Pasturel A, Desgeorges M, De Greslan M. Pdnrtrationtraumatique intra-cranienne d'un condyle mandibulaire. Rev Stomatol Chir Maxillofac. 1976;77:869
[21] Zecha JJ. Mandibular condyle dislocation into the middle cranial fossa. Int J Oral Surg. 1977;6(3):141–6. DOI: 10.1016/s0300-9785(77)80046-x
[22] Kallal RH, Gans BJ, Lagrotteria LB. Cranial dislocation of mandibular condyle. Oral Surg Oral Med Oral Pathol. 1977;43(1):2–10. DOI: 10.1016/0030-4220(77)90342-5
[23] Pieritz U, Schmidseder R. Central dislocation of the jaw-joint into the middle cranial fossa. J Maxillofac Surg. 1981;9:61–3. DOI: 10.1016/s0301-0503(81)80014-8
[24] Ihalainen U, Tasanen A. Central luxation or dislocation of the mandibular condyle into the middle cranial fossa. Int J Oral Surg. 1983;12(1):39–45. DOI: 10.1016/s0300-9785(83)80078-7
[25] Pepper L, Zide MF. Mandibular condyle fracture and dislocation into the middle cranial fossa. Int J Oral Surg. 1985;14(3):278–83. DOI: 10.1016/s0300-9785(85)80040-5
[26] Copenhaver RH, Dennis MJ, Kloppedal E, Edwards DB, Scheffer RB. Fracture of the glenoid fossa and dislocation of the mandibular condyle into the middle cranial fossa. J Oral Maxillofac Surg. 1985;43(12):974–7. DOI: 10.1016/0278-2391(85)90015-1
[27] Musgrove B. Dislocation of the mandibular condyle into the middle cranial fossa. Br J Oral Maxillofac Surg. 1986;24:22.
[28] Paulette SW, Trop R, Webb MD, Nazif MM. Intrusion of the mandibular condyle into the middle cranial fossa: report of a case in an 11-year-old girl. Pediatr Dent. 1989 [Accessed 2022 Apr 14];11(1):68–71. Available from: https://pubmed.ncbi.nlm.nih.gov/2626344/
[29] Engevall S, Fischer K. Dislocation of the mandibular condyle into the middle cranial fossa: Review of the literature and report of a case. J Oral Maxillofac Surg. 1992;50(5):524–7. DOI: 10.1016/s0278-2391(10)80330-1
[30] Chuong R. Management of mandibular condyle penetration into the middle cranial fossa: Case report. J Oral Maxillofac Surg. 1994;52(8):880–4. DOI: 10.1016/0278-2391(94)90243-7
[31] Dahlberg G, Magnusson M, Johansen CC, Rehncrona S. Fracture of the mandibular condyle causing meningeal bleeding. J Oral Maxillofac Surg. 1995;53(4):461–5. DOI: 10.1016/0278-2391(95)90725-4
[32] Tornes K, Lind O. Cranial dislocation of the mandibular condyle. J Craniomaxillofac Surg. 1995;23(5):302–4. DOI: 10.1016/s1010-5182(05)80160-x
[33] Melugin MB, Indresano AThomas, Clemens SP. Glenoid fossa fracture and condylar penetration into the middle cranial fossa: Report of a case and review of the literature. J Oral Maxillofac Surg. 1997;55(11):1342–7. DOI: 10.1016/s0278-2391(97)90199-3
[34] Long X, Hu C, Zhao J, Li J, Zhang G. Superior dislocation of mandibular condyle into the middle cranial fossa. Int J Oral Maxillofac Surg. 1997;26(1):29–30. DOI: 10.1016/s0901-5027(97)80842-9
[35] Barron RP, Kainulainen VT, Gusenbauer AW, Hollenberg R, Sàndor GKB. Fracture of glenoid fossa and traumatic dislocation of mandibular condyle into middle cranial fossa. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002;93(6):640–2. DOI: 10.1067/moe.2002.122824
[36] van der Linden WJ. Dislocation of the mandibular condyle into the middle cranial fossa: report of a case with 5 year CT follow-up. International J Oral Maxillofac Surg. 2003;32(2):215–8. DOI: 10.1054/ijom.2002.0319
[37] Harstall R, Gratz KW, Zwahlen RA. Mandibular Condyle Dislocation Into the Middle Cranial Fossa: A Case Report and Review of Literature. J Trauma. 2005;59(6):1495–503. DOI: 10.1097/01.ta.0000199241.49446.80
[38] Clauser L, Tieghi R, Polito J, Galiè M. Dislocation of the Mandibular Condyle into the Middle Cranial Fossa. J Craniofac Surg. 2006;17(3):590–4. DOI: 10.1097/00001665-200605000-00036
[39] Ohura N, Ichioka S, Sudo T, Nakagawa M, Kumaido K, Nakatsuka T. Dislocation of the Bilateral Mandibular Condyle Into the Middle Cranial Fossa: Review of the Literature and Clinical Experience. J Oral Maxillofac Surg. 2006;64(7):1165–72. DOI: 10.1016/j.joms.2006.03.043
[40] Magge SN, Chen HI, Heuer GG, Carrasco LR, Storm PB, M.D. Dislocation of the mandible into the middle cranial fossa. J Neurosurg Pediatr. 2007;107(1):75–8. DOI: 10.3171/ped-07/07/075
[41] Taglialatela Scafati C, Aliberti F, Scotto di Clemente S, Taglialatela Scafati S, Facciuto E, Cinalli G. Dislocation of a fractured mandibular condyle into the middle cranial fossa: a case treated by an extracranial approach. Childs Nerv Syst. 2008;24(9):1067–70. DOI: 10.1007/s00381-008-0659-8
[42] Man C, Zhu S-S ., Chen S, Jiang L, Hu J. Dislocation of the intact mandibular condyle into the middle cranial fossa: a case report. Int J Oral Maxillofac Surg. 2011;40(1):118–20. DOI: 10.1016/j.ijom.2010.02.028
[43] Vasconcelos BC, Rocha NS, Cypriano RV. Posterior dislocation in intact mandibular condyle: an unusual case. Int J Oral Maxillofac Surg. 2010;39(1):89–91. DOI: 10.1016/j.ijom.2009.07.061
[44] Struewer J, Kiriazidis I, Figiel J, Dukatz T, Frangen T, Ziring E. Dislocation of the mandibular condyle into the middle cranial fossa causing an epidural haematoma. J Craniomaxillofac Surg. 2012;40(5):396–9. DOI: 10.1016/j.jcms.2011.07.006

[45] Tutela JP, Verbist DE, Kelishadi S, Little JA. Traumatic Dislocation of the Mandibular Condyle Into the Middle Cranial Fossa in an Elderly Patient. J Craniofac Surg. 2013;24(5):1703–5. DOI: 10.1097/scs.0b013e31828a76b1

[46] Zhang S, Wu J, Xu B, Shi J, Shen SGF, Gui H. Features and management of intracranial mandibular condyle dislocation after trauma. J Craniomandibular Sleep Practice. 2014;32(1):63–6. DOI: 10.1179/0886963413z.0000000007

[47] Oberman B, Setabutr D, Goldenberg D. Traumatic dislocation of intact mandibular condyle into middle cranial fossa. Am J Otolaryngol. 2014;35(2):251–3. DOI: 10.1016/j.amjoto.2013.11.004

[48] De Mol A, Nicolielo L, Ghekiere O, Jacobs R, Politis C. Dislocation of a mandibular condyle in the middle cranial fossa, diagnosed 54 years after trauma. J Surg Case Rep. 2017;2017(7). DOI: 10.1093/jscr/rjx149

[49] Chen I, Chang C-M, Yuan-Chien Chen M, Chen K-J. Traumatic dislocation of the mandibular condyle into the middle cranial fossa treated by an intraoral approachJ Formosa Med Ass. 2019;118(7):1161–5. DOI: 10.1016/j.jfma.2018.12.025

[50] Dingman RO, Grabb WC. Mandibular Laterognathism. Plast Reconstr Surg. 1963;31(6):563–75. DOI: 10.1097/00006534-196306000-00008

[51] Da Fonseca GD. Experimental study on fractures of the mandibular condylar process (mandibular condylar process fractures). Int J Oral Maxillofac Surg. 1974;3(3):89–101. DOI: 10.1016/s0300-9785(74)80040-2

[52] Zhang S, Wu J, Xu B, Shi J, Shen SGF, Gui H. Features and management of intracranial mandibular condyle dislocation after trauma. J Craniomandibular Sleep Practice. 2014;32(1):63–6. DOI: 10.1179/0886963413z.0000000007

[53] Tsunoda A, Sumi T, Shirakura S, Kishimoto S, Akita K. Bony eminence on the middle cranial fossa corresponding to the temporomandibular joint. Clin Anat. 2007;20(5):512–5. DOI: 10.1002/ca.20447

[54] Rosa VLM, Guimarães AS, Marie SKN. Intrusion of the mandibular condyle into the middle cranial fossa: Case report and review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;102(1):e4–7. DOI: 10.1016/j.tripleo.2006.02.004

[55] Kroetsch LJ, Brook AL, Kader A, Eisig SB. Traumatic dislocation of the mandibular condyle into the middle cranial fossa: Report of a case, review of the literature, and a proposal management protocol. J Oral Maxillofac Surg. 2001;59(1):88–94. DOI: 10.1053/joms.2001.19301