

# Management of maxillofacial fractures within three years of empirical findings

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## SUMMARY

*Objectives.* To investigate which treatment of maxillofacial fractures is more effective and what type of complications is the most common after observed treatment. The second aim is to explore relationship between treated facial bone fractures and temporomandibular joint (TMJ) pathology.

*Material and Methods.* Cases with TMJ pathology in Lithuanian University of Health Sciences (LUHS) in the Department of Maxillofacial Surgery (MS) during 2012-2014 were analysed to research the occurrence of TMJ disorders after facial bone fracture treatment. Moreover, the clinical data of patients that were treated in LUHS in the Department of MS during 2012-2014 was collected and analysed.

*Results.* Male patients had higher fracture ratio (zygomatic and maxillary – 84%, mandibular – 89.72%). Complications occurred in 6% of the patients in a zygomatic and maxillary fractures group, mainly as an infraorbital nerve injury. Closed reduction and indirect fixation were performed for mandibular patients 49.7%. The ratio of complications for mandibular fractures was 6.1%. There were complications in group with the open reduction and direct fixation (24.2%, mostly osteomyelitis), when in the closed reduction and indirect fixation group (42.4%, mostly bone healing complications). There were no patients with TMJ pathology as a complication after facial bone fracture treatment.

*Conclusions.* Fractures treatment technique differs in all cases because of individual characteristics and treatment variations. In the open reduction and direct fixation group complications occurred in fewer cases than in the closed reduction and indirect fixation group. Well-timed facial bone fracture treatment leads to non-occurrence of TMJ complications.

**Key words:** fracture fixation, postoperative complications, mandibular fractures, maxillary fractures, zygomatic fractures, temporomandibular joint disorders.

## INTRODUCTION

Facial fractures are treated by open reduction and closed reduction techniques. The fracture area is immobilized with intermaxillary fixation or other techniques, using screws, plates in order to achieve faster bone healing (1). There are various techniques for fracture treatment but there is no clearly established specific treatment best suited in each case. According to scientific publications open reduction and direct fixation has benefits such as quickly restored chewing function, optimal reposition, and faster rehabilitation. Closed reduction and indirect fixation procedure is

less traumatic, more protecting blood vessels and fracture area, less expensive, followed by a shorter hospitalization time of the patient (2). The purpose of this study is to find out which fracture treatment method is more effective.

The main goals of this research are to evaluate the effectiveness of the fracture treatment techniques, find out which technique leads to lower complications ratio, and verify the temporomandibular joint (TMJ) disorders occurrence after applied fracture treatment. Scientific articles are reviewed on this topic, research of mostly applied techniques was done, and complications incidence rate was investigated. As well as the task is to analyze the data of the patients that were treated for facial fractures and for TMJ pathology separately in the Department of Maxillofacial Surgery in Lithuanian University of Health Sciences (LUHS).

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Analysis of fracture cases data was selected on the aspects of chosen treatment method, the ensuing complications, and further treatment of complications. Analysis of clinical cases with temporomandibular joint disorder diagnosis was investigated to verify if they had facial bone fracture in the case history. The results from literature review and clinical data are compared.

## MATERIAL AND METHODS

Clinical data of 192 patients with temporomandibular joint disorders (TMD) during 2012-2014 years in LUHS Maxillofacial Surgery Department was collected. Main aspect of anamnesis was trauma in maxillofacial region and its treatment. Furthermore DC-TMJ exam form (3) had to be filled to evaluate clinical symptoms of each case. All patients had TMJ symptoms.

Moreover clinical data about maxillofacial fractures in LUHS Maxillofacial Surgery Department during 2012-2014 years was collected, focusing on fracture localisation, treatment, complication type and rate, treatment after complication. Patients were selected if they had facial bone fracture treatment in the Department of Maxillofacial Surgery in Lithuanian University of Health Sciences from 2012 to 2014. Maxillary and zygomatic fractures appeared to 298 patients, mandibular fractures for 559 patients, multiple fractures – 28 patients. Complication occurrence type and rate was explored, complications occurrence reliance from fracture localisation, type and intervention was analysed. Interventions analysis after complications was performed too. Data was systematized, quantitative records analysis was done with records statistical analysis program IBM SPSS 19v. Proof of statistical significance was checked with Fisher criterion. Result was considered as statistically significant if  $p < 0.05$ .

When clinical analysis was fulfilled, literature review was performed through the search of PubMed, Google Scholar databases, with purpose to compare our results of clinical analysis with the results received from literature review. The keywords used for search were "maxillofacial fractures", "zygomatic fracture", "mandibular fracture", "open reduction", "closed reduction", "temporomandibular joint", "temporomandibular disorders", "craniomandibular disorders". The search was restricted to the published date from 1 January 2008 to 31 December 2014. Through the search 2735 articles were found and analysed if they confirmed the topic about advantages and disadvantages of closed reduction and external fixation, open reduction and internal fixation, or com-

plications occurrence rates, 34 articles were found and included (Figure).

## RESULTS

156 patients who complained about TMJ problems were investigated. Mean age value was  $25.3 \pm 1.2$  and 84% of patients were female. Only 2 patients noted the history of facial trauma, especially in mandibular region. One 26 years male patient is professional boxer. He had no history of facial bone fracture but experienced mandibular trauma during boxing once in a while. After mandibular trauma patient experiences the pain in left temporomandibular joint region both at rest and active mandibular movements. When the patient takes nonsteroidal anti-inflammatory drugs, the symptoms disappear till the next mandibular trauma.

Another patient is 22 years female patient with clicking and recurrent pain in temporomandibular joint region on the right. The symptoms started two years ago after mandibular trauma appeared during traffic accident. The patient complained about contusion in facial area without maxillofacial bone fracture.

From all patients there was no case of maxillofacial fracture although trauma in maxillofacial region was the most emphasized aspect in this survey.

Moreover clinical data of 933 patients with maxillofacial bone fracture cases from 2012 to 2014 who were treated in LUHS Maxillofacial Surgery Department was analysed. Maxillary and zygomatic fractures occurred in 298 cases (48 were rejected because of information shortage), mandible fractures in 559 cases (14 were rejected because of information shortage), and multiple fractures in 28 cases (information was rejected because of wide information dispersion).

Results showed that maxillary and zygomatic fractures occurrence by gender was 84% (210 males) and 16% (40 females). Operative treatment (open reduction only, combination of open reduction and direct fixation) was the most frequent. Conservative methods (closed reduction only or combination of closed reduction and indirect fixation) were used less (Table 1).

In the cases of maxillary or zygomatic bone fractures, complications occurred for 6% of the patients. The most frequent complications were infraorbital nerve injuries (Table 2).

The analysis of treatment strategies after complication showed that in the cases where infraorbital nerve lesions appear, pharmacological medicament infusion, neurolysis, and physiotherapy or rest re-

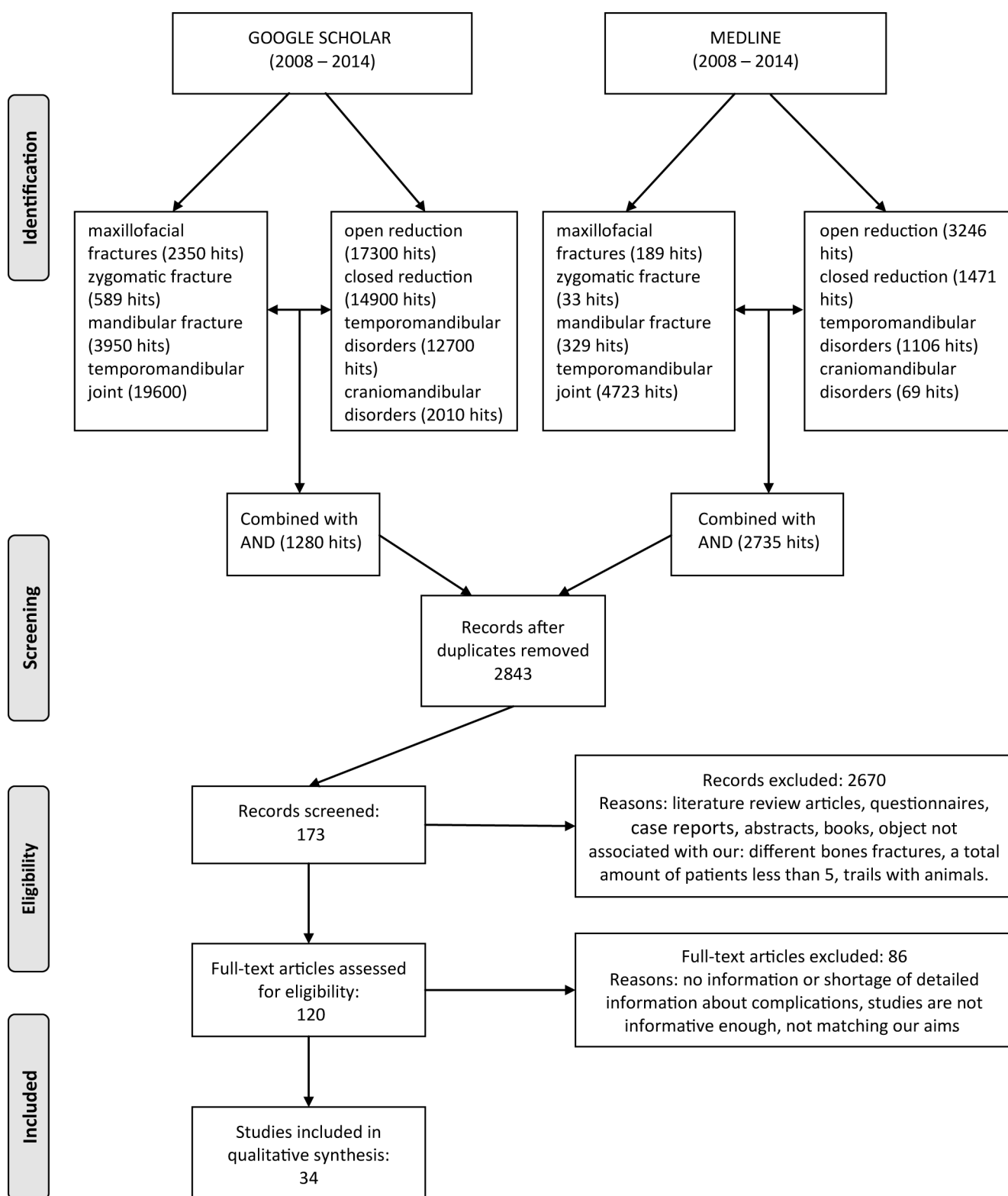


Fig. Flowchart of systematic review and its stages

gime is used the most. If the complication was facial nerve injury, pharmacological medicament infusion was used. When the bone regeneration complication occurred, wire, screw or plate removal, physiotherapy, treatment with pharmacological medicament is performed. If the complication was osteomyelitis, antibiotic therapy, incision with drainage, and sequestrectomy was performed.

When complications occurrence rate (in the cases where different interventions were performed) of zygomaticomaxillary complex was analysed, the results showed that complications occurrence dispersion has no statistical significant results (Fischer test  $P=0.625$ ).

Statistical analysis of patients with mandibular fractures showed that mandibular fractures appear more frequent for male patients 89.72 % (489 males)

than female patients (10.28%, n=56). Mandibular bilateral (40.9%, n=223) and angle (29.4%, n=160) fractures occurred the most frequently (see Table 3). In the cases of bilateral mandible fractures angle and body fractures occurred the most frequently. As well as bilateral body fractures (7.3%) and condylar process and body (9%) fractures occurred quite frequently (Table 3).

In most mandibular fracture cases chosen fracture treatment method was closed reduction and indirect fixation (n=271, 49.7%), and open reduction and direct fixation (38.2%) (Table 4).

When analysis of complications occurrence frequency was performed, the results showed that the cases where closed reduction and indirect fixation were done complications occurrence rate was higher (5.2%) than in the cases where open reduction and direct fixation were performed (3.8%). The results were statistically significant (Fisher test  $P < 0,001$ ) (Table 4).

Complications occurrence rate is 6.1% (n=33) (see Table 5). In most cases complications are bone regeneration complication (n=13, 2.4%) and osteomyelitis (n=12, 2.2%) (Table 6).

After bone regeneration complication, chosen treatment was open reduction and internal fixation (5 patients), closed reduction and external fixation

(3 patients), pharmacological medicament infusion (3 patients), wire, screw, plate removal (1 patient), condilectomy (1 patient). Chosen treatment after osteomyelitis complication was pharmacological medicament infusion (8 patients), closed reduction and external fixation (2 patients), open reduction and direct fixation (1 patient) and sequestrectomy (1 patient). In the cases of phlegmone pharmacological medicament infusion (2 cases), incision and drainage (2 cases), indirect fixation (1 case) and physiotherapy (1 case) was performed. When the complication was abscess, incision and drainage was performed. In the case of periostitis incision, incision with drainage, and pharmacological medicament infusion was performed. There was no case of TMJ pathology as a complication.

When analysis of complication occurrence dependence of fracture localisation was performed, the results showed that complications occurred mostly in these cases where condylar fractures, mandible body and ramus fractures were seen. The results were statistically significant (Fisher test  $P = 0.006$ ) (Table 5).

Moreover when complications occurrence dependency of performed interventions was analysed, complication occurrence between different interventions showed statistically significant results. (Fisher test  $p = 0.024$ ) (Table 6).

**Table 1.** Interventions dispersion in zygomaticomaxillary complex

Intervention	Frequency	Percentage
Open reduction	140	56.0
Open reduction and direct fixation	5	2.0
Closed reduction and indirect fixation	55	22.0
Closed reduction	9	3.6
Clinical inspection	14	5.6
Neurolysis	3	1.2
Closed reduction and external fixation	21	8.4
Wire, screw, plate removal	3	1.2
All in	250	100.0

**Table 2.** Complications type dispersion in zygomaticomaxillary complex. Complications occurrence dispersion has no statistical significant results (Fischer test  $P = 0.625$ )

Complication	Frequency	Percentage
Infraorbital nerve injury	10	4.0
Facial nerve injury	2	.8
Bone regeneration complication	2	.8
Osteomyelitis	1	.4
All in	15	6.0

**Table 3.** Mandible fracture localisation

Intervention	Frequency	Percentage
Angle	160	29.4
Bilateral	223	40.9
Bilateral angle	6	1.1
Angle and condyle	2	0.4
Angle and condylar process	7	1.3
Angle and body	83	15.2
Body and condylar process	1	0.2
Angle and ramus	1	0.2
Body and ramus	26	4.8
Bilateral condylar process	4	0.7
Condylar process and body	49	9.0
Body and coronoid process	2	0.4
Ramus and coronoid process	1	0.2
Bilateral body	40	7.3
Body and alveolar process	1	0.2
Condyle	3	.6
Condylar process	53	9.7
Symphysis and parasymphysis	21	3.9
Body	48	8.8
Multiple	15	2.8
Ramus	13	2.4
Alveolar process	7	1.3
Coronoid process	2	.4
All in	545	100.0

**Table 4.** Complication occurrence in dependence on the intervention performed in mandibular region. The results were statistically significant (Fisher test  $P < 0,001$ ).

Intervention			Complications		Total
			Not occurred	Occurred	
Open reduction	Frequency	37	1	38	
	%	97.4%	2.6%	100.0%	
Incision and drainage	Frequency	0	7	7	
	%	.0%	100.0%	100.0%	
Open reduction and direct fixation	Frequency	200	8	208	
	%	96.2%	3.8%	100.0%	
Clinical inspection	Frequency	8	1	9	
	%	88.9%	11.1%	100.0%	
Teeth removal	Frequency	7	0	7	
	%	100.0%	.0%	100.0%	
Wire, screw, plate removal	Frequency	3	2	5	
	%	60.0%	40.0%	100.0%	
Closed reduction and indirect fixation	Frequency	257	14	271	
	%	94.8%	5.2%	100.0%	
Total	Frequency	512	33	545	
	%	93.9%	6.1%	100.0%	

**Table 5.** Complication occurrence in dependence on the fracture localisation in mandibular region. The results were statistically significant (Fisher test  $P = 0.006$ ).

			Complication occurrence		Total
			Not occurred	Occurred	
Angle	Frequency	150	10	160	
	%	93,8%	6.3%	100.0%	
Bilateral	Frequency	214	9	223	
	%	96.0%	4.0%	100.0%	
Condyle	Frequency	2	1	3	
	%	66.7%	33.3%	100.0%	
Condylar process	Frequency	52	1	53	
	%	98.1%	1.9%	100.0%	
Symphysis and parasymphysis	Frequency	21	0	21	
	%	100.0%	.0%	100.0%	
Body	Frequency	38	10	48	
	%	79.2%	20.8%	100.0%	
Multiple	Frequency	14	1	15	
	%	93.3%	6.7%	100.0%	
Ramus	Frequency	12	1	13	
	%	92.3%	7.7%	100.0%	
Alveolar process	Frequency	7	0	7	
	%	100.0%	.0%	100.0%	
Coronoid process	Frequency	2	0	2	
	%	100.0%	.0%	100.0%	
Total	Frequency	512	33	545	
	%	93.9%	6.1%	100.0%	

In the fracture cases where open reduction and direct fixation was performed, there was noticed higher occurrence of osteomyelitis. In cases where closed reduction and indirect fixation was performed, higher occurrence of bone regeneration complications was noticed.

Literature review was performed (Table 7); the analysis showed that most articles of this subject are published from India (8 of 34) and China (7 of 34). All in all in our study 34 articles were used. Mostly articles about mandibular fractures are published, and usual study object is the treatment results of mandibular condyle fractures (15 of 34). The amount of analysed patients varies from 6 to 2986 patients. A total of 11428 patients' information was analysed.

In zygomatic fractures open reduction and direct fixation (50.6-73.8%) is used more than closed reduction and indirect fixation (9.4-27.3%). Conservative treatment is chosen in 1.7-10.3% of cases. In the treatment of mandibular condyle fractures usually open reduction and direct fixation was chosen (11 of 15 articles about the treatment of mandibular condyle fractures).

In zygomatic fracture cases where open reduction treatment was performed hypoesthesia, diplopia, mouth opening limitation, infection, he-

matoma complications occurred the most, occurrence rate was 19.1%.

In the mandibular fracture cases complication occurrence rates vary from non-occurrence to 28.53%. The most frequent complications in open reduction cases were sensory complications, wound dehiscence, infection.

There are lots of articles (13 of 34) about post-operative TMJ complications after fractures. In most cases TMJ complications, such as TMJ dysfunction, stiffness, functional restrictions (4 articles), TMJ clicking (3 articles), and pain in TMJ area (2 articles) occurred.

## DISCUSSION

The results showed that higher tendency of facial bone fractures exists between male patients (84%), and the same high results are in other studies (4, 5). In mandible fracture cases the most frequent fracture localisation is bilateral fracture and angle fracture (6).

In this study complication occurrence rate was low (6%) while after literature review results showed that complications occurrence ratio varies from non-occurrence to 28.53% (7-16). In zygomatic group complications occurrence ratio varies from non-occurrence to 19,1% (9).

The results of our retrospective analysis showed that in zygomatic and maxillary fractures cases the most common complications were infraorbital nerve injuries. In the mandible fractures cases bone regeneration complication and osteomyelitis. After literature review it was clear that in other studies the most common complication was wound - healing disturbances, nerve trauma, infection and functional impairment (9, 15).

Complications occurrence rate in mandible fracture cases was higher where closed reduction and indirect fixation was performed; the most frequent complication was bone fracture regeneration complication. In our research the most frequent

complication in the cases where open reduction and direct fixation was performed was osteomyelitis. In other studies it is stated that more complications occur where open reduction and direct fixation is performed, and the most frequent complication is nerve injuries and infections (2). Mostly in surgically treated fractures the most frequent complications are infection, wound healing disturbances, nerve injuries, osteosynthesis failure, osteomyelitis, occlusal disharmony, TMJ complications (7, 8, 11, 13-15, 18-30). This kind of research causes uncertainty on the superiority of open reduction and direct fixation method. But still there are publications where the most frequent treatment method was closed reduction (59.52%), and postoperative complications, such as infection, irregular occlusion, TMJ dysfunctions and face asymmetry, occurrence rate was 10.31%. When infection appeared, treatment was applied using antibiotic therapy. When irregular disturbances appeared, mostly reoperation or orthodontic treatment was offered. Temporomandibular joint disturbances were treated by physiotherapy. Face asymmetry was left without treatment (31).

In condylar or subcondylar fracture group correct anatomical position of the fragments was achieved more in operative group (32) and in closed reduction group TMJ dysfunction complications are observed (40). But there are publications where despite the surgical treatment poor anatomical reduction is clinically seen (33). In condylar or subcondylar fracture group mouth opening complications, occlusion disturbances, TMJ complications such as pain, crepitation are observed (19, 20, 22, 26, 29, 30, 32-34). Condylar and subcondylar fractures are often treated endoscopically, and complications after this treatment are infection, fixation failure, temporary facial nerve complication, "Frey" syndrome. In our research complications after condylar and subcondylar fractures appeared in 2 of 56 cases, and there are cases when complications did not occur at all or occur just for temporary period (17, 35-37).

**Table 6.** Complications occurrence dependency of performed intervention in mandibular region. The results were statistically significant (Fisher test  $p=0.024$ ).

	Submandibular abscess	Osteomyelitis	Bone regeneration complication	Periostitis	Phlegmone	Total
Open reduction	0	0	1	0	0	1
Incision and drainage	0	4	0	0	3	7
Open reduction and direct fixation	0	6	1	0	1	8
Clinical inspection	0	0	1	0	0	1
Wire, screw, plate removal	0	0	2	0	0	2
Closed reduction and indirect fixation	1	2	8	1	2	14
Total	1	12	13	1	6	33

Table 7. Main characteristics and findings of reviewed studies (continued on next page)

Study	Country	Sample	Fractures treatment	Main findings. Complications occurrence
K. Hwang, et al. 2011, (9)	Korea	Zygomatic fractures in 469 cases	An open reduction was performed in 73.8% (346 cases), closed reduction in 24.5% (115 cases), and conservative treatment in only 1.7%.	The postoperative complication rate occurred in 88 cases (19.1%) from 461 cases operated: hypesthesia (50 cases, 56.8%), diplopia (15 cases, 17.0%), limitation of mouth opening or closure (11 cases, 12.5%), infection (6.8%), and hematoma (4.5%).
R.A. Kamath, et al. 2012, (21)	India	95 patients (316 facial fractures): 42 zygomaticomaxillary complex fractures, 53 (83 fractures) with concomitant mandibular fractures. 11 only the midface.	92 cases were treated with open reduction and internal fixation (ORIF), and 3 cases were managed conservatively.	The most frequent complications were infection and occlusal disharmony (6 cases each) following operative intervention. 3 cases each of residual swelling and nerve paresthesia were observed. Residual scars resulted in 4 cases and wound dehiscence in 2 patients. The overall complication rate in study was 25.26%.
E.G. Salentijn, et al. 2013, (27)	The Netherlands	A retrospective study of 278 patients with midfacial fractures	Open reduction and direct fixation. In total 292 plates and 1209 screws were used.	Complications consisted mainly of suboptimal fracture reduction (21 patient), temporary paraesthesia of the infraorbital nerve (10 patients), wound infection (9 patients).
R Seemann, et al. 2010, (15)	Austria	322 with 335 surgically treated mandibular angle fractures	95 fractures treated with 1 miniplate, 170 with 2 miniplates, 70 with other osteosynthesis concepts.	Successful treatment occurred in 93.69% of fractures with 1 open reduction and in 6.31% with 2 open reductions. Wound-healing disturbance (51 patient), infection (33), and osteosynthesis failure (19). 71.47% (238) were completely free of complications.
V. Singh, et al. 2010, (32)	India	40 patients with subcondylar fractures of the mandible were evaluated	Closed reduction- 22 patients, open reduction- 18 patients	Correct position of the fragments was achieved significantly more accurately in the operative group. Regarding mouth opening/lateral excursion/protrusion, significant differences were observed between both groups (open 39.6/12.5/5.9 mm vs closed 33.5/9.8/4.1 mm). The visual analog scoring revealed significant difference with less pain in the operative treatment group (1.1 open vs 5.2 closed).
B. van den Bergh, et al. 2011, (27)	The Netherlands	A total of 426 mandibular fracture lines were identified.	213 dentate patients: 29 treated with intermaxillary fixation (IMF), 99- IMF combined with osteosynthesis, 79- IMF only per-operatively to make ORIF possible. 12 edentulous patients: 3- with Gunning splints, 9 by ORIF	60 (26.7%) patients presented with complications, including (transient) hyposensibility of the lip and chin (34 patients), dysocclusion (15 patients), infected osteosynthesis material (6 patients) and temporomandibular dysfunction (5 patients).
S. C. Leuin, et al. 2010, (40)	USA	164 mandibular fractures: 83-condylar or subcondylar (C/SC) fractures. Concomitant fractures for 38 of the 83 C/SC cases.	26 patients were managed medically. 56 patients underwent closed reduction with IMF for an average of 25.7 days (range, 15-43 days). 1 patient underwent an open surgical reduction.	45 patients who completed the questionnaire experienced temporomandibular joint (TMJ) dysfunction after treatment: 6 (13.3%) mild, and 24 (53.3%) severe. Females have more severe dysfunction than do males.
V. Singh, et al. 2012, (38)	India	1038 patients cases with maxillofacial injuries were analysed	ORIF was performed in 72.83% of cases, and conservative management for 22.73%, and 2.5% patients were treated by circum-mandibular wiring.	There was no infection, non-union, mal union, or any functional disability reported in the patients who received IMF for 4-6 weeks. Mouth opening was normal in all patients. TMJ stiffness was during first week of after releasing IMF. It comes normal after a week with physiotherapy.
J. Shi, et al. 2014, (33)	China	83 cases with 159 mandibular and condylar fractures sites were included in the treatment analysis.	Closed treatment was performed in 22 condylar process fractures (28.6%), open reduction- for 55 condylar process fractures (71.4%).	Functional TMJ evaluation showed that overall patient satisfaction rate was 96.4%. 6 patients had deviation of mandibular movement, and all of them had condylar fractures. Clicking in the TMJ was noted at 2 sites and pain in 3 sites; however, there was no significant difference between the conservative treatment and the surgery group.

Table 7. Main characteristics and findings of reviewed studies (continued from previous page/continued on next page)

Study	Country	Sample	Fractures treatment	Main findings. Complications occurrence
T. Eskitascioglu, et al. 2013, (7)	Turkey	753 mandibular fracture patients. All cases had a total of 1090 fractures, the most common was the parasymphysis (28.6%) fracture.	For 25 (3.3%) patients with non-displaced fracture, symptomatic treatment was applied. Closed reduction was performed in 280 (37.2%), osteosynthesis by ORIF for 403 (53.5%); for 134 of these- closed reduction too.	61 (8.1%) patients showed postoperative complications: occlusion disorder, plate exposition, infection, sensory complications, opening at the mucosal sutures, and TMJ dysfunction. There was no complication for patients who were treated conservatively. The lowest complication rates were for patients who had closed reduction alone (9/280) and the highest in patients who had both open and closed reduction (30/134).
J.L. Muñante-Cárdenas, et al. 2010, (24)	Brazil	2986 medical records facial trauma	The conservative treatment was used in 51% of cases, and 49% received surgical treatment.	Postoperative complications identified for 5 patients. From 55 surgically treated cases, 5 (9%) had postoperative complications such as surgical wound dehiscence (1), facial paresthesia (3), infection due to loss of material fixing (1). Complications related to TMJ ankylosis and facial asymmetry were not identified. Authors believe that it was achieved by early mobilization of the TMJ and intensive physiotherapy.
T. Kanno, et al. 2014, (39)	Japan	12 comminuted mandibular fractures with a low-profile locking mandibular reconstruction plate	Anatomical reduction of the comminuted segments re-established the mandibular skeleton in stable occlusion with rigid IMF via extraoral (33.3%), intraoral (50%), or combined (16.7%) approaches.	Immediate functional recovery was achieved. Sound bone healing achieved for all patients, no complications with a mean follow-up of 16.3 months. Preoperative neurological assessment showed paresthesia of mandibular alveolar-mental nerve in 8 cases (67%), and remained after surgery. In some patients, a reduced mouth-opening and limitations in lateral excursion were noted for 1 month postoperatively.
V. Prade, et al. 2014, (35)	France	22 patients (25 mandibular condyle fractures)	The chosen treatment was endoscopically assisted surgical treatment	The complications were: infection (3), fixation failure with good consolidation(1); for combined approaches: temporary facial palsy(2) and 2 cases of Frey syndrome.
J. S. Schenkel, et al. 2014, (14)	Austria	45 patients with comminuted mandibular fractures	ORIF using an intraoral approach was performed	Excellent postoperative results were seen in 84% (38 patients). Postoperative complications were seen in 16% (n=7). Wound dehiscence (7% [n = 3]), osteomyelitis (7% [n = 3]), abscess (4% [n = 2]), bone necrosis (2% [n = 1]), nonocclusion (2%[n= 1]).
V. Singh, et al. 2013, (29)	India	40 patients with an mandibular angle fracture	All patients had a combination of ORIF and maxillofacial fixation.	There was no significant difference between ORIF of displaced fractures (>2 mm) via intraoral approach with application of a single monocortical miniplate versus an extraoral approach with application of an inferior border plate with two holes on either side of the fracture line. Functional outcomes including pain (visual analogue scale score) at the 1-week follow-up and inter-incisal mouth opening at the 12-week follow-up were better in extraoral approach group. In intraoral approach group, 25% of patients (n = 5) had a post-injury/presurgical neurosensory deficit, while in extraoral group, 50% of patients (n = 10) had a post-injury/presurgical neurosensory deficit.
E. Franciosi, et al. 2014, (8)	Argentina	18 edentulous patients, presented a total of 35 mandibular fractures	6 condylar fractures were treated conservatively. 29 fractures were treated with ORIF.	Fracture reduction was considered satisfactory in 96.5%, with 22.2% of complications and 11.1% of reoperations needed. 1 patient required a reoperation due to unstable fracture. Complications: of facial nerve injuries(2) and segments nonunion (1).



Table 7. Main characteristics and findings of reviewed studies (continued from previous page/continued on next page)

Study	Country	Sample	Fractures treatment	Main findings. Complications occurrence
A. Rahpeyma, et al. 2014, (25)	Iran	25 patients (28 fracture lines) with mandibular fractures	Treatment-two perpendicular mini-plates via extraoral approach. Fracture line fixation was made by two mini-plates perpendicular to each other. 1-week IMF and 3 weeks of soft diet was performed.	All patients were followed up for at least 1 year regarding infection and malocclusion. Among the patients who underwent surgery, 1 malocclusion and no cases of infection were observed. No facial nerve weakness cases or damage were observed in this study.
S. Bindra, et al. 2011, (18)	India	10 patients with displaced unilateral/bilateral condylar fractures	Treatment – open reduction and internal fixation of condylar fractures using retromandibular approach	Discrepancy in occlusion was in 5 patients (50%) after 24 h and 1 week postoperatively, but after 3 months showed satisfactory centric occlusion. Mouth opening and laterotrusive movements increased with time. Preauricular tenderness was in 4 patients (40%) after 1 week, in 2 patients (20%) at 6 weeks and none of the patients had preauricular tenderness after 3 months. Out of 10, 2 patients (20%) had clicking in the operated joint one week postoperatively which resolved gradually. 4 patients (40%) had deviation on mouth opening towards the operated joint side after one week but none had any deviation at 6 weeks or 3 months postoperatively.
N. V. V. Reddy, et al. 2012, (26)	India	175 condylar fractures	62.9 % of fractures required ORIF and 37.1 % were managed with closed reduction.	In ORIF group complications were sialocele (2 cases), ear discharge (1), transient facial palsy (19), occlusion disturbances (2), stitch abscess (1), trismus (2), periodontitis (4). In IMF group occlusion disturbances (3 cases), trismus (4), periodontitis (10 cases).
S.T. Xie, et al. 2013, (29)	China	70 patients with condylar head or neck fractures	ORIF was performed for all the patients. 38 were treated with microplates and 32 with miniplates.	The maximal mouth opening was larger in the microplate group than in the miniplate group; scores for bone resorption and condyle morphology were better in the microplate group. Patients from miniplate fixation had a significantly higher incidence of TMJ click.
R Prasad, et al. 2013, (13)	India	20 mandibular fractures in 18 patients	Patients were treated by ORIF using 3D plates.	A significant reduction in lingual splay (72.2%) and occlusal stability (72.2%) was seen. The overall complication rate was (16.6%); post-operative paresthesia of lip (2), infection (3), masticatory difficulty (2). No evidence of non-union, malunion was noted.
Z. Li et al. 2013, (23)	China	13 patients with mandibular condyle dislocations	Treatment: (1) relief of the dislocation by manipulation or open reduction; (2) reduction of the medial condylar fragment, fixation with screws, or (3) removal of the fragment if less than 50% of the condylar width.	Postoperatively, all patients displayed uneventful healing without complications such as postoperative haemorrhage or infection, but 1 patient was with transient facial paralysis with recovery in 2 months. During the follow-up period, no patients showed dysfunction or development of ankylosis, pain.
S. Schiel, et al. 2013, (36)	Germany	6 patients with displaced condylar base and neck fractures (n = 9)	Open surgery, endoscopically assisted reduction and fixation using a transoral route.	All patients had normal occlusion, pain-free unrestricted TMJ function at 3, 6, 12, 18 months postoperatively. There were no signs of incomplete remodeling or deformation.
A. Mijiti, et al. 2014, (11)	China	A total of 1350 patients with maxillofacial fractures were reviewed retrospectively	1860 fractures, 62.4% were treated using open reduction, 27.3% using closed reduction, and 10.3% underwent observation only	97 (7.2%) patients had local complication and 86% of these were found in open reduction and observation groups. The most common complication was transient intraoral or extraoral soft tissue infection (64.8% (63/97) cases), disturbed occlusion and ankylosis 25.8% (25/97) and 4.1%(4/97) of the all complications, osteomyelitis (n=5).
A. A. D. Adam, et al. 2012, (41)	China	310 patients treated for zygomatic bone and zygomatic arch fractures	Patients treated by ORIF with miniplate and screws constituted 90.6%, closed reduction- 9.4%.	Most patients with the zygomatic bone and zygomatic arch had no complication. Clinical examination were performed at 4, 6 and 24 weeks postoperatively.

Table 7. Main characteristics and findings of reviewed studies (continued from previous page)

Study	Country	Sample	Fractures treatment	Main findings. Complications occurrence
Y. Leiser, et al. 2013, (22)	Israel	37 patients had a fracture below the sigmoid notch (low subcondylar)	10 patients were treated using the anteroparotid transmassesteric (APTM) approach, 27 were treated conservatively by maxilomandibular fixation.	In the open reduction group, 2 patients (20%) had limited mouth opening (resolved following physiotherapy); the closed reduction group had mouth opening limitation (below 35 mm) (18.5% of cases). No facial nerve damage was noted.
T. Forouzanfar, et al. 2013, (34)	The Netherlands	41 patients with bilateral condylar fractures	Conservative treatment of bilateral condylar fractures was performed	Of 41 patients, no patient had crossbite, 5 had anterior open bite. No patients with malocclusion had any TMJ pain during 6 months. 5 patients had little intensity or disability. 1 patient had intense pain but little disability, 1 patient had moderately limiting but seriously disabling pain. No patients had severely limiting and seriously disabling pain.
J. H. Zhou, et al. 2013, (30)	China	A total of 78 patients (100 condylar fractures)	A preauricular long-corniform incision for ORIF of mandibular condylar fractures.	The majority of patients in all groups had good occlusion ( $\geq 88.5\%$ ), no pain ( $\geq 89.5\%$ ), and anatomical reduction 10 days after surgery ( $\geq 81.6\%$ ). There were no cases of joint rigidity, plate breakage, or screw loosening. 6 months after surgery, there were 12 cases of mild displacement and 5 cases of poor anatomical reduction. At 6 months follow-up, fracture reduction was ideal in 83% of cases.
R. S. Patil, et al. 2011, (12)	India	10 patients with low subcondylar fracture	These patients were treated by open reduction and internal fixation through intra-oral approach.	All patients followed for 6 weeks, maximum mouth opening was more than 40 mm in 7 patients (range from 40 to 50 mm) and less than 40 mm in 3 patients. Occlusion was satisfactory in all and none showed deviation of mandible on mouth opening.
D. He, et al. 2009, (20)	China	229 patients with 312 intracapsular condylar fracture were treated.	Treatment protocol is open reduction for a fracture in which the superolaterally dislocated ramus stump is out of the glenoid fossa or any type of fracture with displaced or dislocated fragments that may cause TMJ dysfunction later.	Of the joints, ORIF was done for 173; 95.6% had absolute or nearly anatomic reduction. In all of them normal mouth opening and occlusion were restored. No or little deviation was found during mouth opening. Complications - pain in the joint (n=1), crepitations (n=2), facial nerve paralysis (n=1). 2 patients had the plate removed because of complications.
G. Gerbino, et al. 2009, (19)	Italy	50 patients with a total of 57 treated condylar fractures were included.	Open reduction and internal fixation	After surgery via the retromandibular approach, 3 patients had salivary fistulas. 1 patient had an infection after surgery via the submandibular approach. 6 patients showed temporary facial nerve weakness (12%), but all patients recovered facial soft tissue symmetry within 8 weeks. 2 patients had permanent facial nerve palsy (4%). Plate fractures were observed in 4 cases. 3 patients had Frey's syndrome, 3 had malocclusion, 47-habitual occlusion.
R. Schmelzeisen, et al. 2009, (37)	Germany	74 patients with condylar neck fractures	The nonendoscopic extraoral group included 34 patients and the endoscopically assisted open reduction group included 40 patients.	The patients with bilateral fractures in both groups showed decreased function at the first follow-up visit compared with unilateral fractures patients (P = .097 and P = .079). Facial nerve damage was a described complication, occurring in 15 patients in this study.
R. González-García, et al. 2009, (9)	Spain	17 patients with subcondylar fractures	Transoral endoscopic-assisted open reduction and fixation with miniplates	No damage to the facial nerve was observed. No visible scars were present. Transitory hypoesthesia was observed in 3 cases. 6 months after surgery, the TMJ function was not impaired. None of the patients complained of pain. No condylar reabsorption was present.
K. Hwang, et al. 2010, (10)	Korea	2,094 patients with facial bone fractures	Closed reduction was performed in 46.3% of the cases while 39.7% of the cases required open reduction	The complication rate was 6.4% and the most common complication was hypoesthesia (68.4%) followed by diplopia (25.6%). The average follow-up period for hypoesthesia was 1.2 months. The average follow-up period for diplopia was 2 months.

Our study about TMD showed that there was no case of maxillofacial fracture when TMD was noted, and there were some articles with the same results too. In condylar or subcondylar fractures cases where endoscopically assisted reduction and fixation was performed, normal pain-free unrestricted function of the TMJ was seen at 3, 6, 12, 18 months postoperatively, TMJ function problems were not seen in any patient (17, 36). In subcondylar fractures which were treated by open reduction and internal fixation, all patients (n=10) had satisfactory occlusion and no deviation of mandible (12). In the article about trauma it was stated that in cases where early mobilization of TMJ and intensive physiotherapy after conservative or surgical treatment was applied, low postoperative complications rate (9%, n=5) was identified (24).

Although our study about TMD showed that there was no patient with TMJ problem after maxillofacial fracture, there are studies which show different results. Temporomandibular joint complications such as pain, dysfunction, click or stiffness are observed for some time postoperatively (16, 20, 29, 33, 38), and it resolves gradually with time (18, 39). Long term follow-up period is important for TMJ treatment. For example, TMJ function was followed 6 months after surgery, and 18 months follow-up term for occlusion discrepancies and criterion of pain (17, 36). In long term follow-up period most of TMJ complications decrease or disappear without any residual effects. In mandibular fractures where mostly closed reduction and intermaxillary fixation was performed TMJ dysfunction appeared in 30 of 164 cases (40). In mandibular cases where mostly open reduction and internal fixation was performed, postoperative complications rate, including TMJ, was 8.1% (7). In maxillofacial fractures which mostly were managed by open reduction and direct fixation TMJ stiffness appeared during first week after releasing intermaxillary fixation and it became normal after a week of physiotherapy (38). In condylar fracture cases which were treated mostly by open reduction (71.4%), complications such as mandibular movement devia-

tion (6 patients), TMJ clicking (2 cases), and pain (3 patients) was noted (33). In condylar fracture cases where open reduction and internal fixation was performed, in 2 of 10 cases TMJ clicking was noted one week postoperatively which disappeared gradually, 3 of 50 cases showed malocclusion, TMJ click was noted more in osteosynthesis miniplates group than in microplates group (P=0014), pain in TMJ area for 1 of 229, and crepitation for 2 of 229 (18-20, 29). In bilateral condylar fractures cases where conservative treatment was performed, no patients with malocclusion had any TMJ pain during 6 months, 5 patients had little intensity or disability of TMJ (34). There are different results of the studies about TMJ disorders after maxillofacial fracture.

The results of this research showed that results of mandible fractures are statistically significant, but more studies should be made in wider amplitude of years. The results of complications in the cases of zygomatic and maxillary fractures showed no statistical significance; therefore more studies should be done on this object.

## CONCLUSIONS

The success of treatment depends on experience and practical skills of the surgeon and individual fracture conditions; therefore it is impossible to state which treatment technique is superior. Complications rate was higher in these cases where fractures were treated by closed reduction and indirect fixation. In the Department of Maxillofacial Surgery in Lithuanian University of Health Sciences from 2012 to 2014 year complications of facial bones treatment rate was 6%. The most frequent complications were nerve injuries, bone regeneration complications and osteomyelitis. There was any of temporomandibular joint pathology as a complication.

## CONFLICT OF INTEREST

None.

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