Ph.D. Thesis

The role of lower third molars and occlusal support in mandibular angle and condylar fractures

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Pécs, 2020

I. Introduction

A bone fracture is a common pathologic condition, with incidence rates reaching 1 % of the world population a year. The mandible is considered the hardest and most rigid bone of the viscerocranium; however, it is the second most frequently fractured facial bone and the tenth most commonly injured bone of the body. Relevant research findings show that mandibular fractures comprise approximately 36-76% of all maxillofacial fractures. This vulnerability is due to its anatomic position, as it is at risk for maxillofacial trauma situations, and its limited bony support related high degree mobility. The influencing factors for mandibular fracture sites include extrinsic factors (the intensity, site, and direction of the impact), as well as intrinsic factors (the bone shape, density, thickness, musculature, presence or absence of the teeth, and type of occlusal support). Extrinsic factors are related to the etiological factors of the fractures.

Etiological factors of mandibular fractures include motor vehicle accidents, assaults, falls, cycling, and sport activities, and iatrogenesis. The distribution of etiological factors can be affected by geographical location. The majority of mandibular fractures are reported in male patients. It can be explained by the fact, that males may be involved in physical aggression or traffic accidents or sport activities more often than females. According to the literature, the average age of patients with an angle fracture (24.5-37.95 y) is not different from that of patients with a condylar fracture (26.35-36.9 y).

Mandibular fracture site may be influenced by the potential presence and impaction status of lower third molars and the type of occlusal support. The presence of a third molar makes the mandibular angle weaker and increases the risk for its fracture but may lower the risk for condylar fractures. However, when the third molars are absent, the energy is concentrated on the lateral, posterior part of the condylar neck, which may increase the risk for condylar fractures. The presence of occlusal support may be associated with angle fractures, however, the absence of occlusal support may correlate with condylar fractures.

Based on the above mentioned facts the risk for angle and condyle fractures can be modified by the removal of an unerupted lower third molar. Additionally, the treatment of condylar fractures is more challenging and associated with higher morbidity compared to the management of an angle fracture. Thus, the indications for the prophylactic removal of an impacted lower third molar are inconsistent.

II. Objectives

II/1. The role of lower third molars in angle and condylar fractures

The purpose of the first study was to analyze the correlations of the third molar impaction status with mandibular fracture patterns. The investigators hypothesized that third molars, independent of their impaction status, weaken the angular region, meaning that angle fractures are associated with the presence of a lower third molar tooth. In addition, it was hypothesized that angular regions without third molars are less vulnerable, thereby increasing the risk for a condylar fracture. The specific aims were to estimate the risk of occurrence of angle and condylar fractures relative to different depths of impaction (including mesiodistal and apico-coronal impaction status) and angulations of the third molars.

II/2. The role of occlusal support in angle and condylar fractures

The second study focused on investigating the link between occlusal support, angle and condylar fractures, and to examine the role of occlusal support combined with potential presence of third molars in these fractures. According to the hypothesis in the presence of at least one occlusal support in the molar region, the risk for ipsilateral angle fracture may be elevated. The vulnerability of the condylar region may be increased in the absence of occlusal support in the molar region. It was hypothesized that the risk for angle fracture may be increased significantly in the presence of ipsilateral molar occlusal support and lower third molar.

III. Patients and Methods

III/1. Methods of study investigating the role of third molars in angle and condylar fractures

III/1.a. Inclusion criteria

In accordance with the research purpose, a retrospective cross-sectional study was designed (IRB approval: PTE 8094/2019). The study population was composed of patients

presenting with mandibular fractures to the Department of Dentistry, Oral and Maxillofacial Surgery at the Medical School of the University of Pécs (Pécs, Hungary) between December 2005 and May 2019. Patients only with unilateral and isolated angle or condylar fractures of the mandible were included, i.e. included patients had only one fracture, either angle or condylar fracture.

III/1.b. Exclusion criteria

The exclusion criteria were patients who i) were younger than 15 years, ii) had pan facial fractures, iii) had edentulism, iv) had a lower third molar that presented only as a germ, v) had incomplete medical records, vi) had diagnostically insufficient PRs (e.g., a third molar prominently displaced or dislocated or severe positional error of the PR) or vii) had bilateral (angle or condylar) or contralateral fractures.

III/1.c. Study variables

The primary *predictor variable* was the presence or absence of third molars and, when a third molar was present, the impaction status of the third molar. For the impaction status, the positional data comprised horizontal and vertical positions, as assessed by the Pell and Gregory classification. The horizontal position is classified according to the space of eruption between the posterior region of the lower second molar and the anterior border of the ramus (i.e., eruptional space). In class I, there is an adequate amount of space for eruption; in class II, there is inadequate space (half of the crown is covered by the ramus), and in class III, the third molar is located completely or mainly within the ramus. The vertical position was classified according to the level of the highest point of the third molar's crown. In class A, it is at or above the level of the occlusal plane. In class B, it is located between the cementoenamel junction (CEJ) of the adjacent second molar and the occlusal plane. In class C, it is below the level of the CEJ of the adjacent second molar tooth. In addition, the authors divided the impaction cases into 'superficial' (IA, IB, IIA, IIB, IIIA) and 'deep' (IC, IIC, IIIB, IIIC) impaction cases.

Angulation was classified according to Winter's classification. The horizontal inclination between the longitudinal axis of the wisdom tooth and the adjacent second molar was measured. For vertical angulation, the angle is measured to be 10 to -10 degrees; for mesioangular angulation, the angle is measured to be 11 to 79 degrees; for distoangular angulation, the angle is measured to be -11 to -79 degrees; and for horizontal angulation, the angle is measured to be 80 to 100 degrees. Any other types of angulations were classified as 'other', including angulations of 101 to -80 degrees and buccal or lingual inclinations.

The *outcome variable* was the fracture location, i.e., an angle or a condylar fracture of the mandible. Based on the definitions provided by Kelly and Harrigan, a condylar fracture diagnosis was made when the fracture line was at the level of or above the sigmoid notch. An angle fracture was defined as a fracture that runs from a point between the posterior border of the lower second molar and the ramus to a point on the part connecting the lower and posterior margins of the mandible.

Other predictor variables included the patient age, sex, and etiological factors of the trauma. The causes of the fractures were classified as traffic accidents, violent events, sports accidents, falls, and domestic accidents.

III/1.d. Data collection, image analysis

Medical data were collected using the eMedsolution medical software (T-Systems Hungary, Budapest, Hungary), patient charts, and panoramic radiographic (PR) images. The presence or absence of, the position of, and angulation of the impacted third molars were determined using patients' PRs. For fractures that occurred during 2005-2007, conventional PRs (Planmeca Proline PM 2002 CC, Helsinki, Finland) were analyzed using a light box and a light intensity of less than 50 lux in the room. From January 2008, digital PRs were performed in our department (PaX-400C; maximum sensor resolution of 10.42 line pairs/mm, Vatech, Korea). Digital PR analysis was performed using the EzDent software (Vatech). For digital PR analyses, image manipulation was performed with enhancement tools in the viewer (magnification, contrast, brightness, sharpness, invert colorization).

III/1.e. Statistical methods

Statistical analysis was performed using SPSS version 25.0 (IBM, Chicago, USA). The correlations between the predictor variables (presence or absence, impaction status, and angulation of the third molar) and outcome variables (angle versus condylar fractures) were performed using Pearson's chi-square test. The comparison of average age of the angle fracture and condylar fracture groups was performed using the Mann-Whitney two-sample rank sum test. Odds ratios (ORs) of angle fractures were calculated, and logistic regression analysis was also performed to identify significant factors in the etiology of angle versus condylar fractures. After the logistic regression analyses were performed, the adjusted odds ratios of the significant variables were calculated. A p value ≤ 0.05 was considered significant.

III/2. Methods of study investigating the role of occlusal support in angle and condylar fractures

III/2.a. Inclusion criteria

Our second study also followed a retrospective cross-sectional designe (IRB approval: PTE 8094/2019). The subjects of the study included patients with mandibular fractures to the Department of Dentistry, Oral and Maxillofacial Surgery at the Medical School of the University of Pécs (Pécs, Hungary) during the same time period (between December 2005 and May 2019). The inclusion criteria were also identical, therefore only patients with unilateral and isolated angle or condylar fractures of the mandible were included, i.e. included cases had only an angle or condylar fracture.

III/2.b. Exclusion criteria

The exclusion criteria included i) age under 15 years, ii) pan facial fractures, iii) incomplete medical records (such as incomplete or lacking data about type of occlusal support), iv) diagnostically insufficient PRs (e.g., a third molar prominently displaced or

dislocated or severe positional error of the PR) or v) bilateral (angle or condylar) or contralateral fractures.

III/2.c. Study design

The primary *predictor variable* was the presence or absence of occlusal support. Based on the type of the occlusal support the patients were divided into five groups according to Hasegawa et al. Group A included cases of total edentulism, group B consisted of cases with molar occlusal support only ipsilateral to the fracture, in group C included molar occlusal support only contralateral to the fracture, group D was composed of cases of bilateral molar occlusal support, and group E collected remaining other cases, such as cases with minimum one tooth but without molar occlusal support.

The secondary predictor variable was the presence or absence of a lower third molar tooth. Accordingly, four different groups were identified. In group 1 the position of the third molars was only ipsilateral to the fracture, while in group 2 it was contralateral to the fracture. Group 3 was composed of cases with bilateral lower third molar teeth, and group 4 was comprised of cases when the lower third molar teeth were absent. The eruption status and angulation of third molars were not examined in this study.

The *outcome variable* was the fracture site, i.e., an angle or a condylar fracture of the mandible.

Other predictor variables included demographic data and etiological factors as in the previous study.

III/2.d. Data collection, image analysis

The eMedsolution medical software (T-Systems Hungary, Budapest, Hungary), patient charts, and panoramic radiographic (PR) images were used to collect patient data. The presence or absence of the third molars were recorded using patients' digital PRs. Digital PRs were performed in our department (PaX-400C; maximum sensor resolution of 10.42 line pairs/mm, Vatech, Korea). EzDent software (Vatech) was used to analyse digital PRs. For digital PR analyses, image manipulation was performed with enhancement tools in the viewer (magnification, contrast, brightness, sharpness, invert colorization). PRs were used to define the type of the occlusal support in unambiguous cases, i.e. in total edentulism cases, or in

cases when all molar teeth were absent on both sides either in the lower or upper jaw (22 cases). In ambiguous cases the data of occlusion was collected from the patient charts potentially registered on the first visit.

III/2.e. Statistical methods

SPSS version 25.0 (IBM, Chicago, USA) was used to perform statistical analysis. The correlations between the predictor variables (type of occlusal support, presence or absence of the third molar) and outcome variables (angle versus condylar fractures) were calculated using Pearson's chi-square test. Mann-Whitney two-sample rank sum test was used to compare the average ages between the angle fracture and condylar fracture groups. Odds ratios (ORs) of angle fractures were calculated, and logistic regression analysis was also performed to identify significant factors in the etiology of angle versus condylar fractures. After the logistic regression analyses were performed, the adjusted odds ratios of the significant variables were calculated. A p value ≤ 0.05 was considered significant.

IV. Results

IV/1. Results of study investigating the role of third molars in angle and condylar fractures

A total of 740 patients presented to our clinic with mandibular fractures involving a total of 308 cases of angle and/or condyle fractures in the observed period. Bilateral angle fractures occurred in 7 patients, bilateral condylar fractures occurred in 13 patients, and in 9 patients, both the angle and condyle were fractured. Cases of simultaneous condylar and angle fractures and bilateral fracture cases were disclosed. Afterwards, 164 patients with an isolated angle fracture and 115 patients with an isolated condylar fracture were included in our analyses.

Regarding fractures, 34.1% of the angle fractures and 38.6% of the condylar fractures were on the right side of the mandible. The causes of mandibular angle and condylar fractures were interpersonal violence in 122 cases (43.7%), falls in 73 cases (26.2%), traffic accidents

in 37 cases (13.3%), domestic accidents in 23 cases (8.2%), sport accidents in 12 cases (4.3%), and other reasons in 12 cases (4.3%). In the angle fracture group, the etiological factors included 89 assault cases (54.3%), 28 falls (17.1%), 17 traffic accidents (10.4%), 17 domestic accidents (10.4%), 6 sport accidents (3.7%), and 7 other cases (4.3%). The etiological factors in the condylar fracture group consisted of 33 assault cases (28.7%), 45 falls (39.1%), 20 traffic accidents (17.4%), 6 domestic accidents (5.2%), 6 sport accidents (5.2%), and 5 other cases (4.3%).

The mean patient age was 31.6 ± 12.3 (15-74) years in the angle fracture group and 41.9 ± 16.8 (17-89) years in the condylar fracture group. There was a significant age difference between the groups ($p < 0.001$; Mann-Whitney test). The male/female ratio was 88/27 (male = 76.5%) in the condylar fracture group and 137/27 (83.5%) in the angle fracture group ($p = 0.144$; chi-square test).

In 119 of the 164 cases of angle fractures and in 63 of the 115 cases of condylar fractures, a third molar was observed on the side of the fracture. The presence of a third molar correlated significantly with the occurrence of angle fractures (***OR: 2.18***; $p = 0.002$). Angular fractures were significantly more frequent for PG class II (***OR: 2.97***; $p < 0.001$), class III (***OR: 3.42***; $p = 0.03$), and class B (***OR: 5.48***; $p < 0.001$) impactions. According to the special classification (i.e., 'deep' and 'superficial' impactions used in this study), 'deep' impactions exhibited an ***OR*** of ***3.60*** ($p < 0.001$) for angular fracture. Winter's classification of the third molars was not associated with the location of the fractures in this study.

Logistic regression analysis indicated that the patient age (adjusted ***OR: 1.05***; 95% confidence interval [CI]: 1.03-1.07), the absence of a third molar (adjusted ***OR: 0.46***; 95% CI: 0.28-0.76), and third molars with PG class I (adjusted ***OR: 1.86***; 95% CI: 1.09-3.20) or class A (adjusted ***OR: 1.91***; 95% CI: 1.12-3.24) impactions were significant factors for angle versus condylar fractures. An ***OR < 1*** indicated a correlation with an angle fracture, while an ***OR >1*** showed a significant correlation with a condylar fracture.

In 26.37% of the angle fracture cases, the third molar was removed to ensure the most correct position and osteosynthesis.

IV/2. Results of study investigating the role of occlusal support in angle and condylar fractures

In the observed period a total of 740 patients were treated at the Department of Oral and Maxillofacial Surgery of the University of Pécs. After application the inclusion and exclusion criteria a total of 660 cases were excluded from the study. Finaly a total of 80 mandibular fracture cases involving 43 angle and 37 condylar fractures were included in the second investigation.

The right side of the lower jaw was affected by 37.2% of the angle fractures and 43.2% of the condylar fractures. The etiological factors of mandiblular fractures included assault in 35 cases (43.8%), falls in 29 cases (36.3%), traffic accidents in 4 cases (5%), domestic accidents in 2 cases (2.5%), sport accidents in 6 cases (7.5%), and other in 4 cases (5%). Based on the etiology the total of 43 cases of angle fractures were divided into six groups, which included 26 physical aggression cases (60.5%), 8 falls (18.6%), 2 traffic accidents (4.7%), 1 domestic accident (2.3%), 4 sport accidents (9.3%), and 2 other cases (4.7%). Condylar fracture group (37 cases) was composed by 9 assault (24.3%), 21 falls (56.8%), 2 traffic accidents (5.4%), 1 domestic accident (2.7%), 2 sport accidents (5.4%), and 2 other cases (5.4%).

In the angle fracture group the mean age ranged 29.9 ± 12.8 (17-74) years, and it was 46.8 ± 16.8 (17-89) years in the condylar fracture group. The difference between the age of the two groups appaered to be significant ($p<0.001$, MannWhitney test). The male/female ratio was 38/5 (male = 62.2%) in the angle fracture group and 23/14 (88.4%) in the condylar fracture group (***OR: 0.2***; 95% CI: 0.07-0.68; p=0.009; khi-square-test). The condylar fracture group contained significantly more female.

The angule fracture group (43 cases) included 35 cases, where bilateral molar occlusal support presented (81.4%), 2 cases with only ipsilateral molar occlusal support (4.7%), 1 case of total edentulism (2.3%), and 5 other cases (11.6%). No contralateral occlusal support was in the angle fracture group. In the condylar fracture group (37 cases) there was 19 bilateral molar occlusal support cases (51.3%), 2 contralateral molar occlusal support cases (5.4%), no ipsilateral molar occlusal support case, 3 total edentulism cases (8.1%), and 13 other cases (35.1%). Bilateral molar occlusal support associated significantly with angle fractures compared with unilateral molar occlusal support or absence of molar occlusal support. (***OR:***

4.2; 95% CI: 1.50-11.30; p=0.006, khi-square test). Total edentulism occurred most frequently in condylar fracture group, but it was not significant (***OR: 0.3***; 95% CI: 0.03-2.71; p=0.15, khi-square test). The other occlusal support group was significantly more commonly associated with condylar fractures than angle fractures (***OR: 0.2;*** 95% CI: 0.08-0.75; p=0.014, khi-square test).

Regarding the presence or absence of third molars the angle fracture group (43 cases) consisted of 37 ipsilateral third molar cases (86%), 2 contralateral third molar cases (4.7%), and 4 absent third molar cases (9.3%). The condylar fracture group (37 cases) included 16 ipsilateral third molar cases (43.2%), 4 contralateral third molar cases (10.8%), and 17 cases, where third molars were absent (35.1%).

Significant correlation was confirmed between the presence of third molars and the occurrence of angle fractures (***OR: 8.1***; 95% CI: 2.75-23.84; p<0.001, khi-square test). The absence of third molars significantly correlated with condylar fractures (p<0.001). When bilateral occlusal support and third molar were present simultaneously, the risk for an angle fracture was significantly higher (***OR: 15.9***; 95% CI: 4.43-56.81; p<0.001, khi-square test).

Logistic regression analysis was performed to evaluate the influence of the occlusal parameters and demographic variables on fracture pattern; however, significant result was not found due to the small sample size.

V. Discussion

Mandibular fractures are the second most commonly observed maxillofacial bone fractures. In Ellis et al.'s study, of 4711 maxillofacial fracture patients, 2137 patients (45.4%) had at least one mandibular fracture. The influencing factors for mandibular fracture sites include the intensity, site, and direction of the impact, as well as intrinsic factors (the bone shape, density, thickness, musculature, and presence or absence of the teeth, and the type of occlusal support). Numerous studies have analyzed the association between mandibular fracture sites and the potential presence and impaction status of lower third molars but only few investigations analyzed the correlation between type of occlusal support and the mandibular fracture pattern.

The purpose of our first study of 279 mandibular fractures was to analyze the correlations of the third molar impaction status with mandibular fracture patterns. It was hypothesized that the presence of third molars weakens the angular region, increasing the chance of angle fractures, and that the absence of lower third molar teeth significantly increases the risk of a condylar fracture.

The aim of our second study of 80 mandibular fractures was to investigate the influence of occlusal support and mandibular third molars on mandibular angle and condylar fractures. It was hypothesized that the presence of molar occlusal support may lower the risk for condylar fractures and may increase the risk for angle fractures. Furthermore, it was hypothesized that the presence of third molars may significantly increase the risk for angle fractures.

According to the results of previous studies in UK, Germeny, Japan, Canada, USA, South-Korea, and Serbia the main etiological factor of mandibular fractures was assault. Eriksson and Willmar concluded in 1987 that in Malmö (Sweden) between 1952 and 1962 the primary cause of mandible fractures was traffic accident, but between 1975 and 1985 assault became the dominant etiological factor. Similarly to previous findings in our both studies, mandibular fractures were most frequently caused by interpersonal violence, followed by falls, road traffic accidents and sport accidents. In the angle fracture group of both studies, the primary cause was assault, followed by falls. In our both studies the most frequent etiology of injury for the condylar fracture group were falls, followed by the etiology of physical aggression. In our study of 80 cases in condylar fracture group the etiology of sport accidents was ranked third. In the other fracture groups of our both studies the third most frequent etiological factor was traffic accident. Our results were in disagreement with the findings of several studies, such as from Brazil, India, Jordan and Iran, which reported that the main cause of fractures was traffic accident.

As confirmed in numerous similar studies, young adult and middle aged patients are most frequently subjects to angle and condylar fractures. Similar to earlier report findings, we also found that patients who suffered condylar fractures were significantly older than those who suffered angle fractures. As Tiwari et al. stated, angle fracture patients are frequently teenagers and patients in their twenties, in contrast with condylar fracture patients who are typically in their thirties or forties. In spite of this, some studies have failed to prove that age significantly affects the fracture pattern.

Male patients were more frequently affected by mandibular fractures compared to females, which is a finding that is consistent with those in previous reports. Males may be involved in physical aggression more often than females, and in our studies, physical aggression was the main etiological factor in the angle fracture groups and the second main factor in the condylar fracture groups. In our study with smaller sample size, in the condyle fracture group males were affected dominantly, but females were affected significantly more frequently compared with angle fracture cases. It may be related to the main etiological factor, which was the fall in this group. It may be seen more commonly in females. In addition, studies in which traffic accidents were the major cause of injury also found a male dominance.

Numerous studies reported that unerupted lower wisdom teeth may increase the risk of an angle fracture but may decrease the risk of a condylar fracture. Additionally, the impaction status of third molars is also an important factor. Several studies reported that the most significant impaction statuses for angle fractures are PG class II and class B. Giovacchini et al. stated in their meta-analysis that the most significant class of impaction for an angle fracture is class C, followed by class II and class III, while Ruela et al. stated in their meta-analysis that teeth with IIIC impaction have the highest risk for angle fractures. Lee and Dodson reported that the lowest risk for angle fractures was observed in class IIIC impactions, similar to class IA impaction cases. In our studies the presence of unerupted thir molars modified the risk for both fracture types. The presence of an unerupted third molar, especially a PG class II (OR: 2.97), class III (OR: 3.42), or class B (OR: 5.48) molar, significantly correlated with the occurrence of angle fractures in our first study, which is partially consistent with the results of other investigations. In some studies, only the mesiodistal impaction status i.e. the ramus position (I-II-III) was found to correlate with angle fractures. In contrast, in another study, only the vertical impaction status, namely class A impaction correlated significantly with the occurrence of angle fractures. In contrast, Iida et al. and Hasegawa et al. failed to find any association between the impaction status of third molars and the risk of an angle fracture. In a recent meta-analysis conducted by Ruela et al., it was found that the data available in the literature was not sufficiently robust to determine whether the presence of a third molar or the level of impaction is a more decisive factor for the occurrence of angle fractures.

Several previous studies stated that class I and class A positions are observed most frequently with condylar fractures, while class II and class B positions act as protective factors for condylar fractures. Additionally, the absence of a third molar indicates the highest risk for condylar fractures. The absence of a third molar (adjusted OR: 0.46) and class I

(adjusted OR: 1.86) or class A (adjusted OR: 1.91) third molars influenced significantly the occurrence of condylar fractures according to our regression analysis, which confirmed some of the above listed literature findings. According to Antic et al.'s multivariate regression analysis, only the location of the traumatic force was a significant predictor of condylar fractures. In a later finite element analysis they found, that a blow directed at the symphysis region caused a stress concentration in the region of the condyle, irrespective of the presence of a third molar.

In some previous studies, there was no significant association between the fracture pattern and Winter's third molar classification. The current study found similar results. However, Ma'aita and Alwrikat suggested that third molars with vertical and distoangular inclinations are most frequently associated with angle fractures. Inaoka et al. showed that angle fractures were most frequently associated with vertical angulation, followed by mesioangular positions. Antic et al. and Mehra et al. found that vertical angulation is significantly associated with angle fractures, while Patil found that mesioangular position is significantly associated with angle fractures. In addition, Iida et al. found that both mesio- and distoangular positions are significantly related to angle fractures, but when the third molar is incompletely erupted, the association is not significant.

One of the most commonly performed oral surgical procedures worldwide is the extraction of lower impacted third molars. According to Iida et al., the removal of third molars in young athletes decreases the risk of angle fractures but increases the risk of condylar fractures, which are associated with the most severe complications among mandible fractures. Other studies concluded that the prophylactic removal of third molars increases the risk of condylar fractures by the resultant strengthening of the angle region. The results of our first study confirmed that the absence of third molars was significantly associated with condylar fractures. According to our findings it may be concluded that the extraction of an unerupted third molar may increase the risk for the occurrence of a condylar fracture, which may be associated with more and more severe complications compared to an angle fracture. Antic et al. stated that the extraction of unerupted lower third molars to prevent angle fractures is not recommended. In contrast, according to Samieirad et al., it is better to be cautious when recommending retaining impacted third molars only to protect the condyles against probable fractures.

Only few studies in the literature investigate the influence of occlusal support on mandibular angle and condylar fractures. Based on these studies the occlusal support in the molar region may decrease the risk for condylar fractures and simultaneously increase the risk for angle fractures. It can be explained by the fact that the occlusion in the molar region may have a buffering effect on the force exerted on the mandible so that only reduced force may be transmitted to the condylar process. As commonly observed the presence of condylar fractures is frequently associated with ipsilateral molar tooth fractures. Our second study confirming the previous results estabilished that the presence of occlusal support in the molar region may increase the risk for angle fractures and simultaneously significantly decrease the risk for condylar fractures. In the presence of molar occlusal support when third molars were present simultaneously, multiple risk for angle fractures was detected. In case of absence of molar occlusal support, the risk for condylar fractures may be elevated, and the risk for angle fractures may be reduced. In the absence of molar occlusal support the prophylactic removal of a pathology-free and symptomless lower third molar aiming to prevent potentially developing pathologies may modify the mandible fracture pattern in an unfavorable way, especially among patients involved with contact sports.

Our studies were single center studies. As the etiology determines the forces resulting in fractures, a multicenter study should be conducted to better balance the differences across different causes of fractures, e.g., whether altercations or road traffic accidents are dominating causes of fractures. Future research studies should focus on a more precise determination of the influence of bone quantity in the bucco-lingual dimension around third molars (e.g., by applying CBCT) since both Pell-Gregory and Winter classifications measure the molars in the sagittal plane only. Panoramic radiography-based studies are not able to determine whether the bucco-lingual position of the third molar and the corresponding thickness or fenestration of the buccal or lingual bone plates are causes of fractures. Further investigations with high sample size are recommended to analyze the role of occlusal support in mandibular fractures. The high sample size would allow the examination of the correlation of the occlusal support with the mandibular fractures from different etiological factors.

VI. Ph.D. Theses

Based on our first study of 279 fractures the following statements were made:

1) In the presence of lower third molar the risk for an angle fracture may be increased. The risk was 2.18 times higher independently from the impaction status. We found that the risk was 2.97 times higher in PG II, 3.42 times higher in PG III, and 5.48 times higher in PG B impaction status.
2) In the presence of deep impactions (PG I/C, PG II/C, PG III/B, PG III/C) the risk for angle fractures was 3.6 times higher.
3) The fractures of condylar process were significantly related with the absence of third molars or the presence of totaly erupted third molars (PG I/A).
4) In condylar fracture group the mean age was 30% higher compared with the angle fracture group.

Based on our second study of 80 fractures, the following results were achieved:

1) Confirming our first investigation results, the presence of third molars multiplied the risk for angle fractures by 8.1 times.
2) In the presence of molar occlusal support the risk for ange fractures was 4.2 times higher.
3) In the presence of molar occlusal support when third molars were simultaneously present, the risk for an angle fracture was multiplied by 15.9 times.
4) Among older patients in the absence of molar occlusal support or lower third molars, the risk for condylar fractures may increase.

VII. Abbreviations

95% CI = 95% confidence interval

CBCT = cone beam computer tomography

CEJ = cemento-enamel junction

OR = odds ratio

PG = Pell–Gregory

PR = panoramic radiograph

VIII. Publications

VIII/1. Publications Related to the Ph.D. Thesis

- **SOÓS B**; JANOVICS K; TÓTH Á; Di NARDO D; SZALMA J: Association between third molar impaction status and angle or condylar fractures of the mandible - A retrospective analysis. **J Oral Maxillofac Surg 2020;** doi: 10.1016/j.joms.2020.02.005 **Q1; IF$_{2018}$ 1.781**

- **SOÓS B**, JANOVICS K, TÓTH Á, SZALMA J: A bölcsességfog és az okklúzió szerepének vizsgálata a mandibula angulus- és condylustöréseinél. **Orv Hetil 2020;** doi: 10.1556/650.2020.31791

  Q3, IF$_{2018}$ 0.564

VIII/2. Publications Independent from Thesis

- SZALMA J; VAJTA L; LOVÁSZ BV; KISS C; **SOÓS B**; LEMPEL E: Identification of specific panoramic high-risk signs in impacted third molar cases where cone beam computed tomography changes the treatment decision. **J Oral Maxillofac Surg 2020;** doi: 10.1016/j.joms.2020.03.012

  Q1, IF$_{2018}$ 1.781

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VIII/3. Oral presentation

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Cumulative impact factor of thesis related publications: 2.345

Cumulative impact factor of all publications: 10.142

Acknowledgements

I would like to thank Dr. József Szalma for supporting my scientific and clinical work and for his great ideas, leadership and patience.

I am very thankful to my wife and college dr. Kata Janovics for supporting and contributing to my work and for her patience.

I am very grateful to Prof. Dr. Sára Jeges for her statistical analyses.

Special thanks to the staff in our Surgical departments for their selfless work in the everyday patient care, which provided me time for my scientific work.

I would like to thank my family and friends for their support and help.

Last but not least I am thankful to everyone, who are not listed here, but had contributed to my thesis.