Stomatologija, Baltic Dental and Maxillofacial Journal, 5:65-69, 2003

Prediction of Mandible Traumatic Osteomyelitis

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SUMMARY

The purpose of the study was to establish the factors determining development of mandible traumatic osteomyelitis, and to design a method for prediction of the disease. 625 patients who had been treated for mandible traumatic osteomyelitis at KMUC Maxillofacial Surgery Clinic for the period of 1989 to 2001 were examined. The control group consisted of 200 patients whose mandible fractures healed up without any complications. The influence of every factor on the osteomyelitis etiology was estimated as a quantitative indicator, i.e. a risk coefficient (RC). The risk coefficient was calculated as the following: the frequency of the factor in per cents among osteomyelitis suffers was divided by the frequency of the factor among the patients of the control group. The higher than 1 the risk coefficient was, the bigger influence the factor had on the osteomyelitis development. The following factors were estimated to have the highest risk coefficients: carious teeth non-extracted from the fracture line (RC – 11.5), insufficient fixation of fractured (RC – 10.5), immune system disturbances (RC – 10.0), carious teeth extracted from the fracture line later than a week after the trauma (RC – 4.9), specialized treatment applied later than a week after the trauma (RC – 4.4), insufficient reposition of the fractured bones (RC – 3,7). An objective estimation of every quantitative factor gave a possibility to suggest a method for mandible traumatic osteomyelitis prediction. The possibility of traumatic mandible osteomyelitis development was estimated according to the sum total of risk coefficients of individual factors. If the sum total of risk coefficients was higher than 44.4, the possibility of osteomyelitis development was estimated to be 100%, while this sum was less than 21.5, the possibility of osteomyelitis reduced up to 1%.

Key words: mandible fractures, mandible traumatic osteomyelitis.

INTRODUCTION

Osteomyelitis is one of the most common and most complicated complications of mandible fractures. 63 to 95 per cents of facial traumas are mandible fractures (4), 10 to 30 per cents of which complicate in osteomyelitis (1). Traumatic mandible osteomyelitis is an actual problem not only from a medical viewpoint, but also from an economical, social and psychological one, because the people of the most efficient working age (20 to 50 years old) become invalid for a long time.

Traumatic osteomyelitis is mostly impossible to be diagnosed in the initial sudden stage. In this stage of the disease the general state of the patient, whose temperature usually is normal and the composition of peripheral blood does not change, does not change a lot. X-ray diagnostics is effective only in 2 to 3 weeks after the beginning of the disease, when fractured bones loose 30 to 50 per cents of calcium (6). Traumatic mandible osteomyelitis is commonly diagnosed in a chronic stage of the disease, when sequestra form. Then an expensive surgery and long post-operative rehabilitative treatment are necessary. Therefore it is very important that this disease would be predicted and effective preventive measures would be timely applied

In the literature there is a discussion regarding the reasons causing traumatic mandible osteomyelitis development. The authors indicate a lot of local and general factors having an influence on the process of this disease. Some of them give preferences in the etiology of the disease to the microorganisms getting into the sphere of the fracture through the injured mucous membrane directly from the mouth cavity (3, 15, 19) or via haematogenous way from odontogenous infectious focuses (13). Other authors list individual factors having some influence on traumatic osteomyelitis development such as: time of specialized treatment application (2, 7, 13, 15), lesion of soft tissues (14, 19), correct reposition and stable immobilization of fractured bones (5, 12), disturbance of circulation of the blood and innervation (11, 17), hygiene of the mouth cavity (9), teeth in the line of the fracture (8, 15), general immune resistance of the organism (8, 10). There is no doubt that the development of traumatic mandible osteomyelitis of individual patient is determined by a complex of some unhealthy factors the estimation of which would allow predicting the possibility of the disease development and applying timely proper preventive measures. We could not find such studies in the literature.

Therefore the aim of our study was to estimate quantitatively the importance of individual unhealthy factor for osteomyelitis development and according to the quantitative estimation of the complex of factors to establish every patient the possibility of risk when healing of mandible fractures complicates in osteomyelitis.

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Table 1. *Distrubution of examined patients according to sex and age.*

Examined group	In total	Sex				Age (years old)							
		Women		Men		15-44		45-59		60-74		>74	
		n	%	n	%	n	%	n	%	n	%	n	%
GOS	625	86	13.8	539	86.2	470	75.2	144	23.0	11	1.8	-	-
CG	200	30	15.0	170	85,0	152	76.0	40	20.0	8	4.0	-	-

Table 2. *Distribution of examined patients according fracture localization and risk coefficient of osteomyelitis.*

Examined group	In total	Single						Double									
		In teeth arch		In angle		In branch		In teeth		In teeth arch and angle		In teeth arch and branch		In angle		In angle and branch	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
GOS	625	17	2.7	80	12.8	-	-	45	7.2	249	39.8	25	4.0	125			
CG	200	44	22.0	38	19.0	14	7.0	11	5.5	41	20.5	17	8.5	12	6.0	23	11.5
	RK	-		-		-		1.3		1.9		-		3.3		1.2	

MATERIAL AND METHODS

625 patients, i.e. 539 (86,2%) men and 86 (13,8%) women, were examined and treated for mandible traumatic osteomyelitis at KMUC Maxillofacial Surgery Clinic for the period of 1989 to 2001. The control group consisted of 200 patients, whose mandible fractures had healed up without any complications.

Wanting to establish the causes of traumatic mandible osteomyelitis etiology we investigated the frequency of the factors might have had any influence on the disease development within the group of osteomyelitis suffers (GOS) and the control group (CG).

We expressed the influence of the factor on osteomyelitis development as a risk coefficient (RC). We calculated the risk coefficient as the following: the frequency of the factor in per cents within the group of osteomyelitis suffers was divided by the frequency of the factor within the control group.

RC = factor% GOS / factor% CD;

For example, the factor n was established among 80% of osteomyelitis suffers and 20% of the patients of the control group - RC=80/20=4.

The higher than 1 the risk coefficient is, the bigger influence on the osteomyelitis etiology the factor has. According to the sum total of the risk coefficients we calculated the possibility of osteomyelitis development (a criterion of the prediction).

We examined those factors, which could have had any influence on the development of traumatic mandible osteomyelitis: sex and age of the patients, time of application of specialized treatment, fracture localization, the proportion of the teeth to the fracture opening, state of the teeth existing not within the fracture line, quality of reposition of the fractured bones, the fixation method of the fractured bones, immune system.

Sex and age. Distribution of the contingent examined according to their age and sex is indicated in Table 1.

The data delivered in the table show that in all examined groups men dominate. There were 82.2% of men within the group of the patients, whose mandible fractures had complicated in osteomyelitis, and there were 85.0% of men among the patients whose mandible fractures had healed up without any complications. Therefore we can reasonably draw a conclusion that patient's sex has no influence on osteomyelitis development.

Patient's age also has no influence on osteomyelitis development. About two thirds of the patients, both osteomyelitis suffers (GOS) and ones without this disease (CG), were from 15 to 44 years old. The percentage distribution of those patients is analogical in all age groups.

Localization of fractures. The data delivered in Table 2 show that the strongest possibility for getting sick with traumatic osteomyelitis is having the following fractures: a double fracture within the sphere of both angles – risk coefficient 3,3 and a double fracture within the teeth arch and in the angle of mandible – risk coefficient 1,9.

Table 3. *Lesions of face and mouth soft tissues and risk cofficient of osteomyelitis.*

Examined group	Examined totally	Wounds on face skin		Wounds in mouth mucous membrane		Big bruisings	
		n	%	n	%	n	%
GOS	625	136	21.8	550	88.0	24	3.8
CG	200	32	16.0	179	89.5	8	4.0
	RK	1.4		-		-	

Table 4. *Distribution of examined patients according to the duration from trauma to specialized treatment and risk coefficient of osteomyelitis.*

Examined group	Number of examined people	Period passed after trauma till application of specialized treatment (in days)					
		1-2		3-7		>7	
		n	%	n	%	n	%
GOS	625	78	12.5	465	74.4	82	13.1
CG	200	106	53.0	88	44.0	6	3.0
	RC	-		1.7		4.4	

State of the face and soft tissues of the oral cavity. Lesions of the face and soft tissues of the oral cavity are delivered in Table 3.

In the table there is a big quantity of wounds with the sizes of 4 to 18 cm where skin, hypoderma, muscles, and in some cases the oral mucous (open wounds of the cheek) are injured.

More than 20% of the patients – osteomyelitis suffers and 16% of

the patients in the CG whose fractures did not complicate in osteomyelitis, had those wounds.

Therefore we can not deny that big facial wounds when the mandible breaks had no influence on traumatic osteomyelitis development. Definitely, they might not be a direct cause of osteomyelitis development, but with other pathogenesis factors they could have played a certain positive role in the disease development (risk coefficient of osteomyelitis development – 1,4).

Lesions and bruising of the gums and the oral mucous have no important influence on traumatic mandible osteomyelitis.

Time of the application of specialized treatment. Almost two thirds of the patients whose fractures developed in traumatic mandible osteomyelitis (Table 4) had been applied with specialized treatment the first week after the trauma, but, however, only after three days after the trauma at least.

Only about 12.5% of the patients of this group are ones applied with specialized treatment in the course of two first days after the trauma. The later specialized treatment is applied, the stronger possibilities are that healing of fractures complicates in osteomyelitis.

Quality of reposition and fixation of fractured bones. Individual mistakes of the reposition and fixation of fractured bones had not the same influence on traumatic mandible osteomyelitis development (Table 5). Only 12.8% of the patients among osteomyelitis suffers were those, whose fractured bones had not been fixed. These persons did not apply to any medical institutions before osteomyelitis development. Because there was no case without fixation of fractured bones within the examined group where healing of fractures had no complications (CG of the examined group), it may be thought that the unfixed fractured mandible does not heal up without any complications. But it does not mean however that in all cases osteomyelitis must develop.

The width of the opening between the fractured bones less than 1 mm or larger than 3 mm does not have any essential influence on osteomyelitis development.

Methods of treatment. The data delivered in Table 6 show that distribution according to the methods of treatment within the group of the patients, whose healing of mandible fractures complicated in osteomyelitis (GOS) and within the control group (CG) does not differ essentially. It means that the method of treatment (a method of fixation of fractured bones) has no essential influence on traumatic osteomyelitis development.

State of teeth and gums. The data delivered in Table 7 show that the impacted teeth within the fracture line had no influence on healing of fractures and on the development of complications. Therefore applying specialized treatment they may be left and not extracted.

Not impacted teeth within the fracture opening had some influence on osteomyelitis development. Carious teeth and healthy ones, as well, not extracted from the fracture opening may have a great influence on osteomyelitis development during the application of specialized treatment.

After healthy teeth are extracted out from the fracture line before the immobilization of fractured bones the possibility of traumatic osteomyelitis development reduces. However, if this procedure is delayed for 1 to 2 weeks, the possibility of osteomyelitis development increases markedly.

We established that 25% of the patients, whose mandible fractures had complicated in osteomyelitis, had had from 1 to 6 not rehabilitated teeth or they had had clinical symptoms of periodontitis and gingvitis. This pathology had 8% of the examined patient from the control group. It means that teeth and gum diseases increase the possibility of traumatic mandible osteomyelitis development.

Immune system. All examined patients and osteomyelitis suffers had immune pathology as the following: dysfunction of cellular im-

Table 5. *Summary of poor reposition and fixation of fractures and risk coefficient of osteomyelitis.*

Examined group	Number of examined people	Mistakes of reposition				Mistakes of fixation			
		Opening width 1-3 mm		Other dislocation of fractured bones		No fixation		Insufficient fixation	
		n	%	n	%	n	%	n	%
GOS	148	22	14.9	49	33.1	19	12.8	31	20.9
CG	100	12	12.0	9	9.0	-	-	2	2.0
	RC	1.24		3.68		12.8		10.48	

Table 6. *Distribution of examined patients according methods of fractured bones fixation.*

Examined group	Number of examined people	Methods of fixation					
		Wire settings		Kirshenr's spill		Osteosyntesis	
		n	%	n	%	n	%
GOS	554	416	75.1	91	16.4	47	8.5
CG	198	138	69.7	30	15.2	30	15.2

Table 7. *Distribution of examined patients according to treatment tactics of teeth within the fracture line and risk coefficient of osteomyelitis.*

Examined group	Number of examined people	Compacted teeth						Not compacted teeth							
		Extracted during reposition and fixation		Not extracted		Not extracted carious teeth		Not extracted healthy teeth		Extracted healthy teeth during reposition		Carious teeth extracted after 7 – 21 days		Healthy teeth extracted after 7 – 21 days	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
GOS	148	2	1.3	2	1.3	17	11.5	29	19.6	12	8.1	13	8.8	25	16.9
CG	100	-	-	2	2.0	-	-	4	4.0	8	8,0	-	-	4	4.0
	RC	1.3		-		11.5		4.9		-		8.8		4.2	

munity, reduced phagocytosing. The patients of the control group did not have any deviations of lymphocyte phenotype rates from the standard (RC – 10).

Microflora. Mixed microflora was excluded from osteomyelitis focuses of all patients with traumatic mandible osteomyelitis. 86.6% of the patients had an examination of the microorganisms of the staphylococcus group, while 42 per cents – streptococcus.

It should be stated that 69.13% of the osteomyelitis suffers had a gold staphylococcus.

DISCUSSION

The analysis of the factors of traumatic mandible osteomyelitis etiology showed that a lot of factors had some influence on its development. Some of them may be called as the factors predisposing the disease. Under the proper conditions they may induce osteomyelitis development, but they themselves do not however participate in osteomyelitis pathogenesis.

The direct etiopathogenetical factor of osteomyelitis is microorganisms. As the results of our investigation showed that in 86.8% of all cases the cause of osteomyelitis was staphylococcus, mostly (69.13%) – golden staphylococcus. In 42.0% of all cases streptococcus was found in osteomyelitis focuses.

But microorganisms must have certain conditions to produce osteomyelitis. These conditions are determined by general and local factors.

More than 86% of osteomyelitis suffers consisted of men. The age of approximately 80% was from 15 to 44. Our data are coincident with the data of M.P.Sevastyanova (1996), who had indicated that traumatic mandible osteomyelitis was common among the patients whose age was from 20 to 50.

Sex and age of the patients had no influence on traumatic osteomyelitis development, because the distribution of GOS and CG patients according to their sex and age was analogical.

A.V. Kukyenko (1986) indicates that after the first application of specialized treatment after the trauma osteomyelitis develops for 6% of patients. If this treatment is applied after 2 to 7 days after the trauma, mandible fractures complicate in osteomyelitis for 16 to 18% of patients. If specialized treatment is applied later than a week after the trauma, the possibility of osteomyelitis development increases several times.

We established that if specialized treatment was applied later than a week after the trauma, so the possibility of osteomyelitis development increased more than 19 times if it was not applied during the first two days after the trauma.

S. Popkirov (1977), A. G. Shargorodskiy (1985), T. G. Robustova (1996) and other authors consider the lesion of the soft tissues as one of the factors determining osteomyelitis development.

Our investigations showed that big wounds on the face and in the oral cavity could have some influence on osteomyelitis development only if there were other etiopathogenetical factors.

We investigated the influence of localization of fractures on traumatic osteomyelitis development. The highest possibility for traumatic osteomyelitis is as the following: double fracture in the sphere of both angles and double fracture in the angle of the mandible and within the teeth line.

According to the information of our investigation the method of treatment (a method of fixation of fractured bones) has no essential influence on traumatic osteomyelitis development. But the quality of reposition and fixation of fractured bones has a great influence on osteomyelitis development.

Out results obtained are coincide with the opinion of W. R. Proffit (1991) and T. G. Robustova (1996) that the correct reposition of fractured bone and their stable fixation reduce the possibility of traumatic mandible osteomyelitis development.

We investigated the influence of teeth and gums state on traumatic mandible osteomyelitis development. Impacted teeth within the fracture line had no influence on osteomyelitis development. But tributary and carious teeth not extracted out from the fracture line during the application of specialized treatment may cause traumatic mandible osteomyelitis development. Postponing the extraction of such teeth for 1 to 2 weeks may increase significantly the possibility of osteomyelitis development.

Therefore we cannot agree with the opinion of A. G. Shargorodskiy (1985) that tributary teeth within the fracture line can not be the reason of osteomyelitis.

We state the disordered immune system for all our examined patients with the disease of traumatic mandible osteomyelitis: dysfunction of cellular and humoral immunity, weakened phagocytosing. Disordered immune system can undoubtedly have an essential influence on osteomyelitis development.

In the opinion of E. A. Cimbalistova (1985), N. N. Bazhanav (1997) the reason of traumatic mandible osteomyelitis development is general reduction of organism's immunological resistance.

There is no method to estimate the influence of all factors on osteomyelitis development and to enable the possibility to predict the disease.

An objective quantitative estimation of each factor able to influence traumatic osteomyelitis development (establishment of the risk coefficient) gave us a possibility to suggest a method for prediction of mandible traumatic osteomyelitis.

We estimated the possibility of traumatic osteomyelitis development according to the sum total of individual risk coefficients (Table 8). For example, when the sum total of risk coefficients was higher than 44,4, we estimated the possibility of osteomyelitis development to be as 100%, while if the sum total of those coefficients was from 34.7% to 36.5% so we estimated the possibility of osteomyelitis development to be as 50%. The possibility of osteomyelitis development reduces up to 1%, when the sum total of risk criteria is less than 21,5.

Table 8. *Main criteria perdicting osteomyelitis.*

Possibility of osteo-myelitis development	Sum total of risk coefficients	Possibility of osteomye-litis development	Sum total of risk coefficients
100%	>44.4	40%	31.4-34.6
90%	42.5-44.4	30%	28.1-31.3
80%	40.5-42.4	20%	24.8-28.0
70%	38.6-40.4	10%	21.5-24.7
60%	36.6-38.5	1%	<21.5
50%	34.7-36.5		

CONCLUSIONS

1. Development of mandible traumatic osteomyelitis is caused by many local and general factors.

2. Their influence on the development of the disease is not the same. It is estimated by our suggested risk coefficients. The highest risk coefficients are estimated the following factors: carious teeth not extracted out from the fracture opening, insufficient fixation of fractured bones, dysfunction of cell and humoral immunity.

3. The possibility of osteomyelitis development is predicted according to the sum total of the risk coefficients causing it: when the sum total of risk coefficients was higher than 44.4, we estimated osteomyelitis development as 100%, while this sum total was less than 21.5, the possibility of osteomyelitis reduced up to 1%.

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Received: 02 02 2003
Accepted for publishing: 27 06 2003