ORIGINAL ARTICLE UDC: 616.314-002.3-085.28

Empirical antimicrobial therapy of acute dentoalveolar abscess

Empirijska antimikrobna terapija za akutni dentoalveolarni apsces

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Abstract

Background/Aim. The most common cause of acute dental infections are oral streptococci and anaerobe bacteria. Acute dentoalveolar infections are usually treated surgically in combination with antibiotics. Empirical therapy in such infections usually requires the use of penicillin-based antibiotics. The aim of this study was to investigate the clinical efficiency of amoxicillin and cefalexin in the empirical treatment of acute odontogenic abscess and to assess the antimicrobial susceptibility of the isolated bacteria in early phases of its development. **Methods.** This study included 90 patients with acute odontogenic abscess who received surgical treatment (extraction of a teeth and/or abscess incision) and were divided into three groups: two surgical-antibiotic groups (amoxicillin, cefalexin) and the surgical group. In order to evaluate the efffects of the applied therapy following clinical symptoms were monitored: inflammatory swelling, trismus, regional lymphadentytis and febrility. In all the patients before the beginning of antibiotic treatment suppuration was suched out of the abscess and antibiotic susceptibility of isolated bacteria was tested by using the disk diffusion method. **Results.** The infection signs and symptoms lasted on the average 4.47 days, 4.67 days, and 6.17 days in the amoxicillin, cefalexin, and surgically only treated group, respectively. A total of 111 bacterial strains were isolated from 90 patients. Mostly, the bacteria were Gram-positive facultative anaerobs (81.1%). The most common bacteria isolated were Viridans streptococci (68/111). Antibiotic susceptibility of isolated bacteria to amoxicillin was 76.6% and cefalexin 89.2%. **Conclusion.** Empirical, peroral use of amoxicillin or cefalexin after surgical treatment in early phase of development of dentoalveolar abscess significantly reduced the time of clinical symptoms duration in the acute odontogenic infections in comparison to surgical treatment only. Bacterial strains isolated in early stages of dentoalveolar abscess showed high sensitivity to amoxicillin and cefalexin.

Key words:
periapcial abscess; tooth extraction; amoxicillin; cephalosporins; microbiological techniques.

Apstrakt

Uvod/Cilj. Najčešći uzročnici akutnih dentogenih infekcija jesu oralne streptokoke i anaerobne bakterije. Akutne dentoalveolarne infekcije leče se hirurški u kombinaciji sa antibioticima. Empirijska terapija kod ovih infekcija zasniva se na davanju antibiotika na bazi penicilina. Cilj ove studije bio je da se utvrdi klinička efikasnost peroralne primene amoksicilina i cefaleksina u empirijskom započinjanju lečenja akutnih dentogenih apscesa, kao i da se ispita antimikrobna osetljivost izolovanih sojeva bakterija na ove antibiotike u ranoj fazi njihovog razvoja. **Metode.** U istraživanje bilo je uključeno 90 ispitanika sa dentogenim apscesima koji su hirurški lečeni (ekstrakcija zuba i/ili incizija apscesa) i svrstani u tri grupe: dve hirurško-antibiotske grupe (amoksicilin, cefaleksin) i hiruršku grupu. U cilju procene efekata primenjene terapije praćeni su sledeći znaci i simptomi: zapaljenski otok, trizmus, regionalni limfadentitis i febrilnost. Kod svih bolesnika, pre terapije uzet je sadržaj eksudata iz apscesa i određena je osetljivost izolovanih bakterija prema antibioticima. **Rezultati.** U grupi ispitanika koji su dobijali cefaleksin znaci i simptomi infekcije trajali su u proseku 4,67 dana, u grupi koja je primala amoksicilin 4,47 dana, a u hirurškoj grupi u proseku 6,17 dana. U 90 bakterioloških nalaza izolovano je 111 različitih bakterijskih sojeva. Najzastupljenije bile su fakultativno anaerobne gram-pozitivne bakterije (81,1%), a predominantno zastupljena bakterija bila je *Streptococcus viridans* (68/111). Ukupna osetljivost izolovanih bakterija na amoksicilin iznosila je 76,6%, a na cefaleksin 89,2%. **Zaključak.** Peroralna primena amoksicilina ili cefaleksina u ranoj fazi razvoja apscesa, nakon primene hirurškog metoda lečenja, statistički značajno skraćuje trajanje kliničkih simptoma akutne dentogene infekcije u odnosu na one koji su lečeni samo hirurškim metodom. Izolovani bakterijski sojevi u ranoj fazi razvoja apscesa pokazuju visoku osetljivost na amoksicilin i cefaleksin.

Ključne reči:
apsces, periapikalni; zub, ekstrakcija; amoksicilin; cefalosporini; mikrobiološke tehnike.

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Introduction

The most common causes of acute dental infections are oral streptococci and anaerobe bacteria [1, 2]. Acute dentoalveolar infections are usually treated surgically in combination with antibiotics in timely manner [3]. The choice of antibiotics used in acute odontogenic infections treatment is determined by microbiological identification [1]. However, antibiogram tests are not frequently used in everyday therapy of dentoalveolar abscess; they are usually used for more serious infections [4]. Therefore, in most cases treatment is empirically determined [5]. Empirical therapy in such infections usually requires the use of penicillin-based antibiotics, according to the acquired knowledge that greatest number of causes is still susceptible to these antibiotic [4–6].

High consumption and irrational use of antibiotics has triggered the rise of resistant microorganisms [7, 8]. Certain antibiotics such as amoxicillin and cefalexin are being used in clinical practice for a long time now [9]. The development of the resistant bacteria is in proportion with the amount of time for which an antibiotic, or a group of antibiotics has been used [10]. Having this in mind antibiotics need to be periodically re-evaluated [11, 12]. Generally, controversial questions are emerging in regards to the choice of antibiotics and the length of their application for treatment of odontogenic abscess.

The purpose of this study was to determine clinical efficiency of peroral use of amoxicillin, and cefalexin in the beginning of empirical treatment of acute dentoalveolar abscess and to examine antimicrobial sensitivity of isolated bacteria strains to these antibiotics in early phases of dentoalveolar abscess development.

Methods

The study was carried out in the Clinic for Maxillofacial, Oral Surgery and Implantology and the Institute of Microbiology, Military Medical Academy, Beograde as an prospective clinical trial. This study was approved by the Ethic Committee of Military Medical Academy Belgrade.

Ninety randomly selected patients of all age groups and both sexes participated this research. All 90 patients had clinically manifested symptoms of acute odontogenic infections in form of dentoalveolar abscess. Participants were only the patients who had not received any antibiotic treatment prescribed by a doctor or on their own for odontogenic infection, or any other existing infection prior to coming to the Clinic. During the research the patients were not hospitalized.

The patients with allergies to amoxicillin and cefalexin and more serious infections which required hospitalization and /or parenteral antibiotic therapy, as well as the patients with low immunity due to systemic diseases were not included in the study.

The patients were randomly divided into three groups, two of them being treated by chosen antibiotics (amoxicillin or cefalexin) and surgery (tooth extraction, intraoral incision, or tooth extraction with intraoral incision) and the control group, treated by surgery alone.

The group I (amoxicillin) had 30 patients treated with amoxicillin (Amoksicilin, Panfarma d.o.o. Beograd) in daily doses of 2 g (four separate doses of 0.5 g every 6 hours) and surgery, until all the symptoms of the infection were resolved.

The group II (cefalexin) had 30 patients treated with cefalexin (Cefaleksin, Panfarma d.o.o. Beograd) in daily doses of 2 g (four separate doses of 0.5 g every 6 hours) and surgery, until all the symptoms of the infection were resolved.

The group III (control) had 30 patients treated by surgery alone.

In order to evaluate the effects of the applied therapy in all groups of patients the following clinical symptoms were registered: inflammatory swelling, trismus, regional lymphadenitis and febrility.

Diagnosis of inflammatory swelling was based on clinical examination (by palpitation and inspection), and registered on a scale: 0 - no inflammatory swelling, 1 – slightly pronounced inflammatory swelling, 2 – moderate inflammatory swelling, 3 – very prominent inflammatory swelling.

Regional lymphadentytis was diagnosed by clinical examination (palpitation) and evaluated according to the scale previously established: 0 – no inflammation of lymph nodes; 1 – inflamation of regional lymph nodes, palpatory examination painless, 2 – inflammation of regional lymph nodes, palpatory examination painful.

Trismus was diagnosed based on the distance measurement between incisal ridge of upper and lower jaw in case a patient had the teeth; in case the teeth were missing the measurement was based on the distance between alveolar ridges of the frontal region. The results of the measurements were expressed in millimeters (mm). The distance was measured with a caliper. The measured results were evaluated according to the established scale: 0 – there is no trismus (21 mm and more); 1 – slightly pronounce trismus (11–20 mm); 2 – very pronounced trismus (0 –10 mm).

Febrillity was determined by a standard thermometer placed under the armpit. The acquired results were registered as: afebril (up to 36.9 °C), subfebril (37–37.9 °C), febril (38 °C and more).

All the listed symptoms of infection were observed on daily bases, from the day of first medical examination (day 0) when surgery was performed and antibiotic treatment started (in two groups), up to the day when even only one symptom of the infection was still present. In all the patients antibiotic therapy was stopped after full regression of all clinical symptoms of the infection.

In all the patients, on the first day of admission, before the beginning of antibiotc treatment the suppuration was sucked out of the abscess using aspiration method with sterile needle and syringe. Prior to this, specific intraoral region was disinfected using 70% alcohol and *Chlorheksidine digluconat, 0.12% - Galenika ad. Beograd*. The samples were sent to the microbiological laboratory for microbiological testing and identification of bacteria that caused odontogenic abscess and examination of their susceptibility to amoxicillin and cefalexin.

All the samples were cultivated in nutrient permissive blood agar plates which were incubated 18–24 hours at 37 °C

in a thermostat under aerobic conditions. Samples were also cultivated in nutrient permissive blood agar plates enriched with hemin and vitamin K, which were incubated for 48 hours under anaerobic conditions.

All bacteria were identified on morphology of their colonies using classical biochemical identification method, serological identification, automatic reading and interpretation of identification strips ATB expression and API 20 A tests for identification anaerobic bacterial strains.

Clinical and Laboratory Standards Institute (CSLI) Disc diffusion method was regularly evaluated using microorganisms whose susceptibility was already determined. Those were American Type Culture Collection (ATCC) strains: *Escherichia coli (E. coli)* ATCC 25922, *Staphylococcus aureus (S. aureus)* ATCC 25923, *Enterococcus faecalis (E. faecalis)* ATCC 29212 and *Pseudomonias aeruginosa (P. aeruginosa)* ATCC 27853. Microbiological results were expressed as: 1 – Sensitive, 2 – Resistant.

In statistical analysis we used: χ^2 tests and Student *t* test. Significant differences were accepted on $p < 0.05$ level.

Results

Sixty-eight point nine percent of the tested patients were male, and 31.1% were female, 44.5 years old on average. The most common surgical method in 66.6% of the patients was tooth extraction and in 33.3% of the patients abscess incision.

Most of the patients from the first group I had full recovery from all the registered symptoms of the infection on the fifth day (93.3%). The treatment on average lasted for 4.47 days, but significant regression of swelling was recorded on the second day (in 22 of 30 patients) and on the third day (in 27 of 30 patients) from the beginning of the treatment (Table 1).

In the group II the full recovery from all registered of infection was registered on the fifth day (90.0%) (Table 2). On average the treatment lasted for 4.67 days. A significant regression of swelling was recorded on the second day (in 23 of 30 patients) and on the third day (in 27 of 30 patients) from the beginning of the treatment (Table 2).

In these groups none of the patients manifested clinical symptoms of odontogenic abscess such as trismus and febrility.

In the group III of the patients the full recovery from all registered symptoms of infection occurred on the seventh day (93.3%). On average, in this group of the patients the treatment lasted for 6.17 days, although the significant regression of swelling was recorded on the third day (in 25 of 30 patients), and on the fourth day (in 26 of 30 patients) from the beginning of the therapy (Table 3). In the group III none of the patients manifested trismus nor febrility as a clinical symptom of odontogenic abscess.

The statistical analysis indicated that there was a significant difference in duration of the symptoma in groups of patients treated with antibiotics and patients from the control group. In fact, the use of amoxicillin or cefalexin after surgical treatment reduced significantly the duration of clinical symptoms of odontogenic abscess compared to the surgically only treated group ($\chi^2 = 3.980$, $p < 0.05$; $t = 9.1283$, $p < 0.05$, for amoxicillin and $\chi^2 = 1.630$, $p < 0.05$; $t = 7.9108$, $p < 0.05$, for cefalexin) (Table 4).

Table 1

Influence of surgical treatment + amoxicillin on the intensity and duration of clinical symptoms in patients with acute odontogenie abscess

Clinical symptoms intensity*	Number of patients										
	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Swelling											
0	0	0	0	0	20	28	30	30	30	30	30
1	16	17	22	27	9	2	0	0	0	0	0
2	14	13	8	3	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
Regional lymphadenitis											
0	0	0	0	0	18	28	30	30	30	30	30
1	12	14	19	24	10	2	0	0	0	0	0
2	18	16	11	6	2	0	0	0	0	0	0

*Explanation for symptoms intensity are given in Methods

Table 2

Influence of surgical treatment + cefalexin on the intensity and duration of clinical symptoms in patients with acute odontogenic abscess

Clinical symptoms intensity*	Number of patients										
	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Swelling											
0	0	0	0	0	13	27	30	30	30	30	30
1	19	21	23	27	16	3	0	0	0	0	0
2	11	9	7	3	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
Regional lymphadenitis											
0	0	0	0	0	13	27	30	30	30	30	30
1	16	16	20	26	15	3	0	0	0	0	0
2	14	11	10	4	2	0	0	0	0	0	0

*Explanation for symptoms intensity are given in Methods

Table 3

Influence of surgical treatment alone on the intensity and duration of clinical symptoms in patients with acute odontogenic abscess

Clinical symptoms intensity*	Number of patients										
	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Swelling											
0	0	0	0	0	0	8	19	28	30	30	30
1	17	19	22	25	26	19	10	2	0	0	0
2	9	7	5	3	4	3	1	0	0	0	0
3	4	4	3	2	0	0	0	0	0	0	0
Regional lymphadenitis											
0	0	0	0	0	0	8	22	28	30	30	30
1	19	19	20	22	24	16	3	1	0	0	0
2	11	11	10	8	6	6	5	1	0	0	0

*Explanation for symptoms intensity are given in Methods

Table 4

Influence of different treatments on clinical symptoms duration in patients with acute odontogenic abcess

Treatment	Duration of clinical symptoms (day 1) $\bar{x} \pm SD$
Surgery	6.17 ± 0.81
Surgery + amoxicillin	4.47 ± 0.62*
Surgery + cefalexin	4.67 ± 0.65*

***p* < 0.05 *vs* surgery treatment**

There were no significant differences in the duration of the symptoms between the two study groups of patients treated with antibiotics.

A total of 111 bacteria strains were isolated from 90 patients. The most common were Gram-positive facultative anaerobic bacteria (81.1%), especially *Streptococcus viridians* (68/111) (Table 5).

According to antibiogram analyses, susceptibility of isolated bacteria to amoxicillin was 76.6%, and cefalexin 89.2%. Highest susceptibility was registered in *Streptococcus viridans* to both amoxicilllin (67/68) and to cefalexin (65/68). Greatest resistance among Gram-positive facultative anaerobic bacteria was found in the strains of *Staphylococcus coagulases negative* (8/9) and *Staphylococcus aureus* (2/2) to amoxicillin, among facultative anaerobic Gram-negative bacteria strains in *Klebsiella spp.* (4/4) to amoxicillin, and cefalexin (3/4) and in *Serratia spp.* (3/3) to both of them, in strictly anaerobic bacteria strains *Peptostreptococcus* (1/2) also to both of them (Table 6).

Table 5

Isolated bacteria in patients with acute odontogenic abscess (n = 90 patients)

Isolated bacterial strains		n	%
Facultative anaerobic Gram – positive bacterial strains 90/111	*Streptococcus viridans*	68	61.2
	Streptococcus spp.	1	0,9
	Enterococcus faecalis	3	2.7
	Staphylococcus aureus	2	1.8
	Streptococcus anginosus	1	0,9
	Streptococcus ß - haemoliticus group G	3	2.7
	Streptococcus ß - haemoliticus group F	1	0.9
	Streptococcus pneumoniae	1	0.9
	Enterococcus casseliflavus	1	0.9
	Staphylococcus – coagulases negative	9	8.1
Facultative anaerobic Gram – negative bacterial strains 15/111	*Serratia spp.*	3	2.7
	Serratia marcenscens	1	0.9
	Esherihia colli	2	1.8
	Enterobacteri species	1	0.9
	Klebsiella spp.	4	3.6
	Moraxella catharalis	2	1.8
	Proteus mirabilis	1	0.9
	Comamonas acidovorans	1	0.9
Strict anaerobic bacterial strains 6/111	*Propioni – bacterium spp.*	2	1.8
	Bifido - bacterium	1	0.9
	Peptostreptococcus spp.	3	2.7
Total		111	100

Table 6

Sensitivity (S)/resistance (R) of bacterial strains isolated from adontogenic abscess

Bacterial strains	Amoxicillin		Cefalexin	
	S	R	S	R
Streptococcus viridans	67	1	65	3
Streptococcus spp.	1	0	1	0
Enterococcus faecalis	2	1	3	0
Staphylococcus aureus	0	2	2	0
Streptococcus anginosus	1	0	1	0
Streptococcus ß - haemoliticus group G	3	0	3	0
Streptococcus ß - haemoliticus group F	1	0	1	0
Streptococcus pneumoniae	1	0	1	0
Staphylococcus – coagulases negative	1	8	7	2
Enterococcus casseliflavus	1	0	1	0
Serratia spp.	0	3	0	3
Serratia marcenscens	0	1	0	1
Esherihia colli	2	0	2	0
Enterobacteri species	0	1	0	1
Klebsiella spp.	0	4	1	3
Moraxella catharalis	1	1	2	0
Proteus mirabilis	0	1	0	1
Comamonas acidovorans	0	1	1	0
Propioni – bacterium spp.	2	0	2	0
Bifido - bacterium	1	0	1	0
Peptostreptococcus spp.	1	2	1	2
Total	85	26	99	12

Discussion

Basic principles in the treatment of acute odontogenic abscess is to remove the cause perfmorming adequate drainage; most common approach is tooth extraction and/or abscess incision [4]. Even though surgical therapy is considered to be the most important procedure in the acute odontogenic abscess treatment [13], there is no significant amount of data on isolated application of surgical method in the literature [14]. Belasy and Hairam [14] quote that a group of patients which was not treated with antibiotics was successfully cured after seven days, the same as a group treated with antibiotics, although the regression of pain and swelling on the second and the third day was more progressive in patients who had received antibiotics. The results of our research showed that all the patients from surgical group were successfully cured using only surgical method without antibiotic treatment; this indicates the importance of early removal of odontogenic abscess cause.

The use of antibiotics represents the most important complementary method in surgical treatment of acute dental infections, even though in the literature we come across various information related to the use of antibiotics and duration of treatment [15, 16]. Ideally, antibiotic treatment should be applied according to existing symptoms of clinical infection; when the regression of symptoms occurs it should be stopped [1]. Topazian et al. [17] indicated that the antibiotic should be used untill all the microbes from infected area are completely removed, otherwise a recurrence may occur. Most of the authors recommend a 7-day therapy in dental abscess treatment, with the remark that less than seven days of therapy is hardly ever recommended [4, 6, 18, 19].

On the other hand, some researchers consider that the duration of antibiotic therapy can be shorter if a patient is exhibiting signs of infection regression; under these circumstances there is no need to extend the therapy [1, 14, 16, 20].

The results of our research show that with acute dentoalveolar abscesses it is helpful to prescribe antibiotic in addition to surgical method because it reduces the time needed for full recovery. However, antibiotics should not be used more than it is necessary, especially when the treatment is evidently giving fast results, and it should be stopped at the moment of complete regression of infection symptoms.

Some earlier researchers have indicated positive therapeutic efficiency of amoxicillin in the treatment of acute dental infections [16, 20, 21]. Sixou et al. [22] in the study conducted on 26 patients with pericoronal infection with predominantly anaerobic flora isolates, found that amoxicillin exhibited strong antimicrobial activity. Craig and Xia [23] in the study of susceptibility of bacteria isolated from endodontic abscess indicated high susceptibility of isolated bacteria to amoxicillin.

Today, the majority of authors point out that most of the bacteria causing odontogenic abscess are strictly anaerobic. However, there are authors whose studies are indicating different information (showing different results). Rega et al. [24] in a study performed on 103 patients point out that of 269 isolated bacteria strains, 178 (65.7%) were facultative anaerobic bacteria, the most common bacteria was *Streptococcus viridans.* In Bresco–Salinas and al [25] study conducted on 64 patients with dental infection, Gram-positive facultative anaerobic bacteria (68%) were most frequently present. We came across similar data in studies of other authors [26–28]. Data from the studies of quoted authors fully correlates to the results of our research.

The application of small doses of antibiotics, or long-term application of the same, increases the possibility of resistant strains origination. Therefore, it has been indicated that there is an increase in origination of resistant bacteria to a wide range of antibiotics, especially those from beta-lactamic group, which were widely prescribed in the therapeutic treatment of this infection [29]. Literrio et al. [30] showed susceptibility of isolated anaerobic bacteria on beta-lactam antibiotics group was lowest to ampicillin. Also, Eckert et al. [31] indicated the resistance of isolated anaerobic bacteria 24% to ampicillin.

Rotimi et al. [32] tested susceptibility of bacteria from *Streptoccocus viridans* group to 11 antibiotics. Resistance to amoxicillin was 40.8 %, and to cefalexin 25.3%. In a research conducted in 43 medical centers in USA over a period of one year smallest antibacterial activity was found in cefalexin (15%) in regards to 352 bacteria from *Streptococcus viridans* group [33].

The *in vitro* level of susceptibility of isolated bacteria to tested antibiotics, in our research was considerably high. Traub and Leonhard [34, 35] suggested that susceptibility of isolated bacteria to ampicillin was 66.9% , and to cefoxitin 76.6%. Rozkiewicz et al. [36] point out that out of 426 *Streptococcus viridians* isolated bacteria strains, the smallest resistance (16.7%) was registered to ampicillin. Also, Matijevic et al. [37] showed that the very high percentage of isolated bacterial strains from dentoalveolar abscess was sensitive to ampicillin (70.5%).

Conculusion

Empirical, peroral use of amoxicillin or cefalexin after surgical treatment in early phase of development of dentoalveolar abscess significantly reduced the time of clinical symptoms duration in the acute odontogenic infections in comparison to surgical treatment only. Bacterial strains isolated in early stages of dentoalveolar abscess showed high sensitivity to amoxicillin and cefalexin.

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The paper received on October 20, 2008.