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ORIGINAL ARTICLE

Prevalence, duration and aetiology of bacteraemia following dental extractions

I Tomás[1], M Álvarez[2], J Limeres[1], C Potel[2], J Medina[3], P Diz[1]

[1]*Department of Special Needs, School of Medicine and Dentistry, Santiago de Compostela University, Santiago de Compostela, Spain;* [2]*Research Laboratory, Department of Clinical Microbiology, Xeral-Cíes Hospital, Vigo, Spain;* [3]*Department of Anaesthesiology, Santiago de Compostela University Hospital, Santiago de Compostela, Spain*

OBJECTIVE: To investigate the prevalence, duration and aetiology of bacteraemia following dental extractions, analysing the factors affecting its development.
SUBJECTS AND METHODS: The study group was composed of 53 patients undergoing dental extractions under general anaesthesia. Peripheral venous blood samples were collected at baseline and at 30 s, 15 min and 1 h after the dental extractions. Samples were inoculated into BACTEC PLUS aerobic and anaerobic blood culture bottles and were processed in Bactec 9240. Subculture and further identification of the bacteria isolated was performed by conventional microbiological techniques.
RESULTS: The prevalence of bacteraemia following dental extractions was 96.2% at 30 s, 64.2% at 15 min and 20% at 1 h after completing the surgical procedure. The bacteria most frequently identified in the positive blood cultures were *Streptococcus* spp. (63.8%), particularly *Streptococcus viridans*.
CONCLUSIONS: In our series, the majority of patients undergoing dental extractions developed bacteraemia, usually of a streptococcal nature, independently of the grade of oral health and of the number of extractions performed. Positive blood cultures persisted for at least 1 h after the dental procedure in a considerable number of patients, questioning the supposedly transient nature of bacteraemia following dental extractions.
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Keywords: focal infection; bacteraemia; dental extractions; *Streptococcus viridans*

Correspondence: PD Dios, C./Panamá 2; 2 dcha, 36203 Vigo, Spain. Tel: +34 981 563100 (ext. 12344), Fax: +34 981 562226, E-mail: pdiz@usc.es
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Introduction

Bacteraemia constitutes an essential step in the pathogenesis of some focal infections of oral origin (Gendron *et al*, 2000). Okell and Elliott (1935) were the first to demonstrate the presence of bacteria in the bloodstream following dental extractions. Since then, many authors have studied the prevalence of bacteraemia associated with dental extractions (BDE) (Elliott and Dunbar, 1968; Peterson and Peacock, 1976; Shanson *et al*, 1978, 1985; Baltch *et al*, 1982; Otten *et al*, 1987; Roberts and Radford, 1987; Coulter *et al*, 1990; Heimdahl *et al*, 1990; Cannell *et al*, 1991; Göker and Güvener, 1992; Hall *et al*, 1993; Okabe *et al*, 1995; Roberts *et al*, 1997, 1998; Rajasuo *et al*, 2004a,b), reporting rates which vary between 39% and 100% (Okabe *et al*, 1995; Roberts *et al*, 1997).

In 1997, the American Heart Association (AHA) (Dajani *et al*, 1997) stated that bacteraemias of oral origin are of a transient nature as they do not usually persist for more than 15 min after completing the dental procedure. Under normal conditions, these bacteria move from the bloodstream to the tissues and are rapidly eliminated by the reticuloendothelial system. According to this AHA statement (Dajani *et al*, 1997), the majority of studies published on the prevalence of BDE have only determined bacteraemia between 10 and 15 min after the procedure, detecting positive blood cultures in up to 80% in some series (Hall *et al*, 1993).

In many reports, *Streptococcus viridans* were the bacteria most frequently isolated in post-extraction blood cultures (Heimdahl *et al*, 1990; Roberts *et al*, 1992, 1997; Takai *et al*, 2005). In contrast, a predominance of obligate anaerobes was found in other series on BDE, with rates between 65% and 70% (Hall *et al*, 1993; Okabe *et al*, 1995).

However, differences in the methodology used and in the characteristics of the study groups make it difficult to compare the results on the prevalence and aetiology of BDE reported in different series. Furthermore, the influence of factors such as the oral health status, the

number of teeth extracted and the difficulty of the surgical technique is currently a matter of debate.

The aim of this study was to investigate the prevalence, duration and aetiology of BDE, analysing the factors affecting its development.

Patients and methods

Selection of the study group

The study group was composed of 53 patients who, for behavioural reasons (autism, cerebral palsy, learning disabilities, hyperactivity, phobias, etc.), underwent dental extractions under general anaesthesia in the Santiago de Compostela University Hospital (Spain). The following exclusion criteria were applied: patients who had taken antibiotics in the 3 months prior to the study (including antibiotic prophylaxis for the surgical procedure in the present series), routine use of oral antiseptics, patients suffering from any type of congenital or acquired immunodeficiency, and any other disease which could predispose to infections or bleeding.

The project was approved by the Ethics Committee of the Faculty of Medicine and Dentistry of the University of Santiago de Compostela. Informed consent for participation in the study was obtained from the patients or their legal representatives in all cases.

Determination of oral health status

After recording the age and gender from each patient, a single dentist completed the intraoral examination after nasotracheal intubation and before carrying out the dental extractions gathering information on: plaque deposits (simplified Greene and Vermillion oral hygiene index) (Greene and Vermillion, 1964), calculus deposits (Ramfjord calculus index) (Ramfjord, 1967), presence of gingival bleeding (Löe and Silness gingival index) (Löe and Silness, 1963), depth of periodontal pockets (Ramfjord index) (Ramfjord, 1967), degree of dental mobility (Ramfjord dental mobility index) (Ramfjord, 1967), number of decayed teeth (including root remnants), and the presence of submucous abscesses and periapical lesions detected clinically and/or radiologically. The type (primary or permanent) and number of teeth extracted was also recorded.

The oral health status was graded in each patient using a specifically designed and previously validated scale which included criteria of dental and periodontal health (Diz *et al*, 2000). The scale ranged between 0 (healthy mouth) and 3 (neglected mouth).

Collection of samples for blood culture

To determine the prevalence of BDE, peripheral venous blood samples were collected from each patient at baseline (after nasotracheal intubation and before local anaesthetic injection with articaine and adrenaline), and 30 s after the final dental extraction. Further samples of peripheral blood were taken at 15 min and 1 h after finishing the surgical procedure in order to evaluate the duration of bacteraemia (the final blood sample could only be obtained from 50 patients because of technical reasons). Collection, handling and transport of the blood samples for blood culture were performed according to the recommendations of the Spanish Society of Infectious Diseases and Clinical Microbiology (Romero *et al*, 1993).

Microbiological analysis of blood cultures

Bottles with the aerobic and anaerobic culture media (BactecPlus; Becton Dickinson and Company, Sparks, MD, USA) into which the blood samples were inoculated were processed in Bactec 9240 (Becton Dickinson). A Gram stain was performed on each positive blood culture. The positive blood cultures in the aerobic media were subcultured on blood agar and chocolate agar in an atmosphere of 5–10% CO_2, and on MacConkey agar under aerobic conditions. The same protocol was used in the positive blood cultures in the anaerobic media, with subculture on Schaedler agar and incubation in an anaerobic atmosphere. The bacteria isolated were identified using the battery of biochemical tests provided by the Vitek system (bioMerieux Inc., Hazelwood, MO, USA) for Gram-positive bacteria, *Neisseria* spp./*Haemophilus* spp. and obligate anaerobic bacteria. *Streptococcus viridans* were classified into five groups: *mitis*, *anginosus*, *salivarius*, *mutans* and *bovis*, applying the Ruoff criteria (Ruoff *et al*, 1999; Ruoff, 2002).

Statistical analysis

The results were analysed using the SPSS version 12.0 statistical package for Windows (SPSS Inc., Chicago, IL, USA). Multivariate analyses were performed to study the factors associated with the development of BDE using binary logistic regression. The odds ratio (OR) was calculated to estimate the impact of a risk factor and its significance was evaluated using the confidence interval (95% CI). Fisher's exact test was used to compare the oral health status (grades 0–1 *vs* grades 2–3) between the patients presenting BDE and those with negative blood cultures.

Results

Characteristics of the study group

The study group was composed of 29 (55%) men and 24 (45%) women, with a mean age of 26.1 ± 12.3 years (range 8–52 years). The results of the intraoral examination are presented in Table 1. On the scale of oral health, 10 patients (19%) were grades 0–1, 21 (40%) grade 2 and 22 (41%) grade 3.

Prevalence and duration of post-extraction bacteraemia

At baseline, 9.4% of the patients presented positive blood cultures. The prevalence of bacteraemia was 96.2% at 30 s after the final dental extraction, 64.2% at 15 min and 20% at 1 h after completing the surgical procedure.

Characteristics and identification of the bacteria isolated

Of the 209 pairs of blood culture bottles used, 100 were positive (bacterial growth in at least one bottle of the pair). A single bacterium was identified in 71 of the positive blood cultures, two bacteria in 26, three bacteria

Table 1 Oral health status and mean of dental extractions performed in the study group ($n = 53$ patients)

	Number of patients (%)
Dental plaque[a]	
Grade 0–1	19 (36)
Grade 2–3	34 (64)
Calculus[b]	
Grade 0–1	20 (38)
Grade 2–3	33 (62)
Gingival bleeding[c]	
Grade <3	24 (45)
Grade 3	29 (55)
Periodontal pockets[d]	
<4 mm	28 (53)
≥4 mm	25 (47)
Dental mobility[e]	
Grade 0	34 (64)
Grade ≥1	19 (36)
Decayed teeth (number)	
≤5	19 (36)
6–10	21 (40)
>10	13 (24)
Submucous abscess and/or periapical lesion	
No	25 (47)
Yes	28 (53)
Dental extractions	5.7 ± 4.7

[a]Simplified Greene and Vermillion oral hygiene index.
[b]Ramfjord calculus index.
[c]Löe and Silness gingival index.
[d]Ramfjord index
[e]Ramfjord dental mobility index.

in two, and four different bacteria in the remaining blood culture. A total of 133 bacterial strains were isolated of which 10 (7.5%) were aerobes, 110 (82.7%) were facultative anaerobes and 13 (9.8%) were obligate anaerobes. With respect to their Gram stain pattern and morphology, 105 (70.9%) were Gram-positive cocci, 11 (8.3%) Gram-negative cocci, six (4.5%) Gram-positive bacilli and 11 (8.3%) Gram-negative bacilli.

The genera and species of the 133 bacteria identified in the positive blood cultures are shown in Table 2. The most frequent were *Streptococcus* spp. (63.8%), particularly *S. viridans*, followed by *Staphylococcus* spp. (11.2%) and *Neisseria* spp. (7.5%). Of the 73 isolates of *S. viridans*, 44 (60%) belonged to the *mitis* group, 21 (29%) to the *anginosus* group, four (5.5%) to the *salivarius* group, three (4.1%) to the *bovis* group and one (1.4%) to the *mutans* group. The most prevalent obligate anaerobes were *Fusobacterium* spp. (three isolates), *Peptostreptococcus* spp. (two isolates), *Bacteroides* spp. (two isolates) and *Prevotella* spp. (two isolates).

Table 3 shows the distribution of the bacterial isolates with respect to the time of collection of the blood samples. At baseline, five isolates were detected (three *Staphylococcus* spp., one *Streptococcus* spp. and one *Bacteroides* spp.). Immediately after the dental extractions, the predominant bacterial genus was *Streptococcus* spp. (69.4%), followed by *Neisseria* spp. (9.6%). In the blood samples collected 15 min after the dental extractions, *Streptococcus* spp. were the most frequently identified bacteria (63.6%), followed by *Staphylococcus* spp. (13.5%). Twelve isolates were identified in the blood samples collected 1 h after completing the dental extractions (six *Streptococcus* spp., four *Staphylococcus* spp. and two *Lactobacillus* spp.).

Factors related to the development of bacteraemia
A statistical analysis of the factors potentially contributing to bacteraemia 30 s after the final dental extraction was not performed as there were only two patients with negative blood cultures.

At 15 min after ending the surgical procedure, 79.2% of the women presented positive blood cultures *vs* 51.7% of the men. Of the patients with gingival inflammation grade <3 (no presence of spontaneous gingival bleeding), 79.2% presented positive blood cultures *vs* 51.7% of those with grade 3 (presence of spontaneous gingival bleeding). Female gender and a degree of gingival inflammation <3 were significantly related to bacteraemia 15 min after the dental extractions. At this sampling time point, the risk of developing bacteraemia was five times higher in females than in males (OR = 5.385; 95% CI = 1.356–21.378), and five times higher in patients with a degree of gingival inflammation <3 compared to those with grade 3 (OR = 0.186; 95% CI = 0.047–0.737). The age, the levels of plaque and calculus, the presence of periodontal pockets, the dental mobility, the number of decayed teeth, the presence of submucous abscesses and/or periapical lesions, and the number of teeth extracted were not significantly related to bacteraemia 15 min after the dental extractions.

None of the variables that were studied showed a statistically significant association with the persistence of bacteraemia 1 h after the dental extractions.

No statistically significant differences in the oral health status (grades 0–1 *vs* grades 2–3) were observed at any of the sampling time points between the patients presenting BDE and those with negative blood cultures.

Discussion

Prevalence and duration of post-extraction bacteraemia
In contrast to the findings reported in some series (Roberts *et al*, 1997; Lucas *et al*, 2002), a number of authors did not detect bacteraemia at baseline in patients undergoing dental treatment (Heimdahl *et al*, 1990; Okabe *et al*, 1995). In some studies it has been shown that nasal intubation causes bacteraemia in almost 10% of cases (Depoix *et al*, 1987; Roberts *et al*, 1997). We recently studied the prevalence of bacteraemia under basal conditions (with no prior manipulation) and after performing endotracheal intubation (I Tomás, P Diz, unpublished data); extrapolating the results to the present study, the majority of positive blood cultures detected in the first blood sample would correspond to bacteraemia following nasotracheal intubation.

There is a wide variation in the prevalence of BDE in the literature reviewed, ranging from 39% to 100% (Okabe *et al*, 1995; Roberts *et al*, 1997). A questionable methodological variable is the time at which the blood sample is taken after the dental extraction. Heimdahl

Table 2 Bacteria identified in the positive blood cultures ($n = 133$ isolates)

	n (%)		*n* (%)
Streptococcus spp.		*Staphylococcus* spp.	
Streptococcus viridans			
Streptococcus mitis group	44	Coagulase-negative *Staphylococcus*	4
Streptococcus anginosus group	21	*Staphylococcus capitis*	3
Streptococcus salivarius group	4	*Staphylococcus auricularis*	3
Streptococcus bovis group	3	*Staphylococcus schleiferi*	2
Streptococcus mutans group	1	*Staphylococcus epidermidis*	1
Other *Streptococcus* spp.		*Staphylococcus sacharolyticus*	1
Other *Streptococcus* spp.	12	*Staphylococcus haemolyticus*	1
Total	85 (63.8)	Total	15 (11.2)
Neisseria spp.		*Fusobacterium* spp.	
Neisseria cinerea	8	*Fusobacterium varium*	2
Neisseria mucosa	1	*Fusobacterium nucleatum*	1
Neisseria suflava	1	Total	3 (2.2)
Total	10 (7.5)		
Peptostreptococcus spp.		*Actinomyces* spp.	
Peptostreptococcus micros	2	*Actinomyces odontolyticus*	2
Total	2 (1.5)	Total	2 (1.5)
Gemella spp.		*Bacteroides* spp.	
Gemella morbillorum	2	*Bacteroides fragilis*	1
Total	2 (1.5)	*Bacteroides distasonis*	1
Lactobacillus spp.		Total	2 (1.5)
Lactobacillus acidophilus		*Haemophilus* spp.	
Total	2	*Haemophilus parainfluenza*	2
Prevotella spp.	2 (1.5)	Total	2 (1.5)
Prevotella corporis		*Enterococcus* spp.	
Total	2	*Enterococcus gallinarum*	1
Eubacterium spp.	2 (1.5)	Total	1 (0.8)
Eubacterium aeroficiens		*Veillonella* spp.	
Total	1	*Veillonella parvula*	1
Bifidobacterium spp.	1 (0.8)	Total	1 (0.8)
Bifidobacterium spp.		*Pantoea* spp.	
Total	1	*Pantoea aglomerans*	1
Enterobacter spp.	1 (0.8)	Total	1 (0.8)
Enterobacter aerogenes			
Total	1		
	1 (0.8)		

Table 3 Distribution of bacterial isolates [*n* (%)] with respect to the time of collection of the blood samples

	Baseline[a]	*30 s*[b]	*15 min*[c]	*1 h*[d]
Streptococcus spp.	1 (20)	50 (69.4)	28 (63.6)	6 (50.0)
Staphylococcus spp.	3 (60)	2 (2.8)	6 (13.5)	4 (33.2)
Neisseria spp.		7 (9.6)	3 (6.8)	
Fusobacterium spp.		2 (2.8)	1 (2.3)	
Actinomyces spp.		2 (2.8)		
Peptostreptococcus spp.		2 (2.8)		
Lactobacillus spp.				2 (16.8)
Haemophilus spp.		1 (1.4)	1 (2.3)	
Gemella spp.		1 (1.4)	1 (2.3)	
Prevotella spp.		1 (1.4)	1 (2.3)	
Bacteroides spp.	1 (20)		1 (2.3)	
Enterobacter spp.		1 (1.4)		
Pantoea spp.		1 (1.4)		
Enterococcus spp.		1 (1.4)		
Eubacterium spp.		1 (1.4)		
Bifidobacterium spp.			1 (2.3)	
Veillonella spp.			1 (2.3)	
Total	5 (100)	72 (100)	44 (100)	12 (100)

Blood sample collected at [a]baseline (before any dental procedure and after nasotraqueal intubation), [b]30 s, [c]15 min and [d]1 h after the dental extractions.

et al (1990) performed the sampling during dental manipulation and Roberts *et al* (1997) and Okabe *et al* (1995) at 30 s and at 2 min, respectively, after completing the surgical procedure. Roberts *et al* (1992) studied the prevalence of BDE in a group of 229 children at different times after the procedure (at 10, 30, 60, 90, 120, 180 and 600 s); in this study, the highest prevalence of bacteraemia was reached at 30 s after the dental extraction. Based on this report (Roberts *et al*, 1992), the first sample in our series was taken at 30 s after completing the dental extractions, detecting a prevalence of bacteraemia >95%, as found by other authors (Heimdahl *et al*, 1990; Lockhart, 1996).

Probably in view of the transient nature attributed to bacteraemia of oral origin (Dajani *et al*, 1997), the prevalence of BDE has only been determined between 10 and 15 min after the procedure in the majority of studies published in the literature, with rates of detection in the range of 20–80% (Heimdahl *et al*, 1990; Hall *et al*, 1993; Lockhart *et al*, 2004). In this study, we observed bacteraemia in almost 65% of cases 15 min after completing the dental extractions.

In a recently published series by Lockhart *et al* (2004), which included 51 children undergoing dental treatment under general anaesthesia, bacteraemia persisted for up to 45 min after the dental extractions in 14% of the patients. Göker and Güvener (1992) studied the persistence of BDE at 1 and 24 h after the surgical procedure; positive blood cultures were found in 28% of patients at 1 h (similar to the percentage obtained in the present study) and in 8% at 24 h. These results put in question

the supposedly transient nature of BDE as previously suggested by other authors (Lockhart, 1996; Roberts, 1999).

Micro-organisms responsible for post-extraction bacteraemia

In many studies performed both in children (Roberts *et al*, 1992, 1997) and in adults (Heimdahl *et al*, 1990; Takai *et al*, 2005), *S. viridans* were the most frequently isolated bacteria in post-extraction blood cultures, representing between 60% and 85% of all the bacteria identified. In agreement with these findings, almost 65% of the isolates in the present study were *Streptococcus* spp., with a predominance of *S. viridans* of the *mitis* group, followed by the *anginosus* group. Haffajee *et al* (1998) observed that the prevalence and levels of streptococcal species were similar in adults with and without periodontal disease and in elderly patients undergoing periodontal maintenance. Van der Reijden *et al* (2001) also demonstrated that the prevalence of *Streptococcus mutans* in samples of subgingival plaque did not vary significantly between patients with different degrees of periodontitis. These results could explain why *S. viridans* were the bacteria which most frequently caused BDE in our series.

As *Staphylococcus* spp. are considered commensal micro-organisms of the skin, some authors systematically exclude these isolates from their series because they consider them to be indicative of contamination (Otten *et al*, 1987). However, *Staphylococcus* spp. have been related to the development of gingivitis and periodontitis (Noguerol *et al*, 1997; Smith *et al*, 2001). Murdoch *et al* (2004) also recently detected the presence of staphylococcal species in more than half of the samples obtained from the gingival sulcus, palate and floor of the mouth in subjects with no periodontal disease (compared to 71% in patients with periodontitis). In the present study, these bacteria were the second most common genus, being isolated in 11% of the positive blood cultures, a similar percentage to that observed by other authors (Peterson and Peacock, 1976; Hockett *et al*, 1977; Roberts *et al*, 1992). Roberts *et al* (1998) detected *Staphylococcus* spp. in 9% of the positive post-oral surgery blood cultures, indicating that up to 6% of these cultures could be attributed to contamination, and therefore the remaining 3% were indicative of staphylococcal bacteraemia of oral origin. Assuming this contamination-associated percentage, the estimated prevalence of BDE resulting from *Staphylococcus* spp. in our series would be 5%.

Factors probably related to the development of post-extraction bacteraemia

Age

Okabe *et al* (1995) demonstrated that the frequency of positive post-extraction blood cultures was significantly lower in individuals under 20 years of age than in those over 60 years of age (42% *vs* 86%). These authors justified their results on the basis that plaque and calculus accumulation and periodontal injuries were less frequent in younger patients (Okabe *et al*, 1995). Lockhart *et al* (2004) confirmed that the prevalence of BDE increased significantly with age. In the present study, age was not a factor affecting the prevalence or duration of BDE. However, no cases of bacteraemia were detected 1 h after performing the dental extractions in patients under 15 years of age compared with 27% in patients over 30 years of age, probably because patients younger than 15 years presented a substantially lower accumulation of calculus and fewer periodontal pockets (14% *vs* 72% and 21% *vs* 60% respectively).

Gender

Very few authors have analysed the influence of gender on the prevalence of BDE (Okabe *et al*, 1995). Okabe *et al* (1995) observed no statistically significant, gender-related differences in the prevalence of BDE. However, a significantly higher prevalence of BDE at 15 min was detected in females in the present study (with a higher value also observed at 1 h). No significant differences were observed in the oral health status between females and males. It has been suggested that gender could affect the prevalence of certain septic episodes, although a higher susceptibility of one or the other gender is controversial (Eachempati *et al*, 1999; Offner *et al*, 1999). In this respect, many experiments performed in animals have demonstrated that the immune response to bacteraemia could differ between males and females (Yanke *et al*, 2000) due to the immune modulating properties of the sex hormones on certain cells of the immune system on which specific receptors for these hormones have been identified (Angele *et al*, 2000).

Oral health status

No definitive conclusion has been reached on the influence of the oral health status on the prevalence of BDE (Coulter *et al*, 1990; Roberts *et al*, 1998). Coulter *et al* (1990) found no significant relationship between plaque indices and the prevalence and intensity of BDE in a group of children. Takai *et al* (2005) detected a higher prevalence of bacteraemia after dental extractions in individuals with periodontitis than in those with no periodontal disease. In contrast, Lockhart (1996) demonstrated that BDE in adults was independent of the periodontal condition. In the present study, the levels of plaque and calculus, the presence of periodontal pockets and dental mobility did not influence the prevalence or duration of BDE.

Some authors have found a higher prevalence of bacteraemia of oral origin in adults and children with gingivitis (Lineberger and De Marco, 1973; Berger *et al*, 1974; Roberts *et al*, 1998). Roberts *et al* (1998) even suggested that the health of the gingival tissues not only affected the prevalence of BDE but also probably its intensity, by conditioning the size of the bacterial inoculum. Paradoxically, in the present study we observed that the rate of BDE at 15 min was significantly higher in those patients with no spontaneous gingival bleeding (and this rate was also higher at 1 h). It has been shown that inflammatory processes

cause an increase in the vascularized dentogingival surface area (an area of 5 cm^2 can increase to 20 cm^2), with the presence of a high level of immune mediators (Slots, 2003), possibly explaining the results obtained in the present study based on a 'local immune hyperactivity'.

It has been reported that the presence of odontogenic abscesses does not influence the prevalence of BDE (Robinson *et al*, 1950; Peterson and Peacock, 1976). However, other investigators detected a higher frequency of bacteraemia after the extraction of teeth with periapical lesions (Okabe *et al*, 1995; Takai *et al*, 2005). No significant differences were observed in the present study in the prevalence and duration of BDE between patients with submucous abscesses and/or periapical lesions in the teeth extracted and those who did not present these infectious processes.

It has been demonstrated that even patients with a good oral health status present significant supra- and subgingival bacterial concentrations (Ximénez-Fyvie *et al*, 2000; Barlow *et al*, 2004); this may explain why the prevalence and duration of BDE in the present series were not associated with the grade of oral health.

Type and number of teeth extracted

Heimdahl *et al* (1990) demonstrated that a single dental extraction led to a higher frequency of bacteraemia than other procedures such as third molar surgery or bilateral tonsillectomy, suggesting that bacteraemia is not related to the aggressiveness of the surgical procedure. As observed by other authors (Otten *et al*, 1987; Heimdahl *et al*, 1990), Rajasuo *et al* (2004a) recently found only 20% of positive blood cultures in the first 5 min after the extraction of unerupted mandibular third molars. These authors concluded that the prevalence of BDE was higher in erupted than in unerupted teeth, probably due to the bacterial accumulation on the surface of the tooth and in the gingival sulcus of the erupted tooth (Rajasuo *et al*, 2004a). Elliott and Dunbar (1968) and Peterson and Peacock (1976) observed that the extraction of primary teeth caused bacteraemia in a considerable percentage of cases (32% and 36% respectively) although, in both series, this was lower than the rate detected after the extraction of permanent teeth (64% and 61% respectively). In the present series, 9 of the 10 patients in whom primary teeth were extracted presented positive blood cultures at 30 s.

In agreement with the results of previous studies (Robinson *et al*, 1950; Bender *et al*, 1963), Okabe *et al* (1995) found that the frequency of positive blood cultures significantly increased with the number of teeth extracted (65% in cases of one to five extractions *vs* 100% in patients with more than 15 extractions). Subsequently, Roberts *et al* (1997) also detected a higher percentage of bacteraemia ($>50\%$) in children in association with multiple extractions than with a single dental extraction (39%). In contrast, Coulter *et al* (1990), in a series in children, observed that the number of teeth extracted did not influence the prevalence or intensity of BDE, and Heimdahl *et al* (1990) and Lockhart (1996) detected bacteraemia in almost 100% of adults after performing a single dental extraction. As found by these latter authors (Coulter *et al*, 1990; Heimdahl *et al*, 1990; Lockhart, 1996), the number of teeth extracted did not influence the rate of bacteraemia detected at 30 s, 15 min or 1 h post-extraction in the present study.

In conclusion, in our series the majority of patients in whom dental extractions were performed developed post-extraction bacteraemia, usually of a streptococcal nature, independently of the grade of oral health and number of teeth extracted. Positive blood cultures persisted for a minimum of 1 h after completion of the procedure in a considerable number of patients, questioning the supposedly transient nature of BDE.

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