CARDIOVASCULAR MEDICINE

Duration, prevalence and intensity of bacteraemia after dental extractions in children

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Objective: To investigate the duration, prevalence and intensity of bacteraemia after dental extractions in children by comparing within-patient bacteraemia before and after dental extraction.
Methods: Children were randomly allocated to one of 10 postprocedure time groups from 10 s to 60 min. The differences between intensity and prevalence of the bacteraemia at each time after extractions were used to estimate the duration of the bacteraemia. After attainment of general anaesthesia, pre-extraction and postextraction blood samples were processed by broth culture and lysis filtration to isolate and quantify bacteria present in the patients' blood.
Results: 500 subjects between 3 and 16 years old were recruited. The estimated duration of bacteraemia was about 11 min.
Conclusions: The duration of bacteraemia after dental extractions is less than previously thought. This has implications for the interpretation of odontogenic bacteraemia studies.

Bacteraemia follows almost all dentogingival manipulative procedures.[1] This has led to the belief that the development of bacterial endocarditis is a complication after dental treatment in patients at risk, although evidence for this is equivocal.[2] The assessment of the need for prophylaxis encompasses the anticipated duration of bacteraemia. A detailed review estimates the duration of bacteraemia to be from less than 10 min to greater than 180 min.[3] Even this comprehensive review overlooked an important Finnish paper published in 1970.[4]

Most studies have used dental extractions as the surgical stimulus for the generation of odontogenic bacteraemia. Such studies have not used a preprocedure blood sample, as it was believed that blood cultures before dental treatment are all negative.[5 6] This is untenable, as lysis filtration has shown that up to 86% of blood samples are positive before the procedure.[7 8] Blood samples from both before and after the procedure are required to estimate the true intensity, prevalence and duration of bacteraemia associated with a dental procedure.

PATIENTS AND METHODS

Ethical considerations

The project was approved by the Eastman Dental Hospital Research Ethics Committee (JREC 980005).

Sample size

The sample size estimate was based on a preoperative value of 9.3% positive blood cultures and a postoperative value (60 s) of 38.0%.[9] A sample size of 47 patients in each group would be required to have a power of 90% of detecting a difference in the proportions with bacteraemia of 31% at the 5% level of significance. To provide some leeway, each group was made up of 50 patients by using restricted randomisation for the allocation procedure.[10]

To encompass the times selected, 500 patients provided 1000 blood samples.

Patients

Children attending the Eastman Dental Hospital for treatment under general anaesthesia constituted the preliminary sample group. Exclusions were antibiotic usage within the previous month,[11] viral carriage, haemorrhagic disorders and body weight less than 17.5 kg. Each family was approached, the study was explained, and an information sheet was provided. Once parents had read this they signed a consent form agreeing to participation. For older children (> 9 years) permission was also sought from them.

Methods

An orodental examination was carried out according to the World Health Organization criteria for dental caries.[12] Plaque and gingivitis were assessed on each tooth by dividing the perimeter into quadrisections and assessing both plaque and gingivitis as present or absent.[13] Also, partial plaque and gingivitis indices were derived which were restricted to the teeth that were extracted.

Children were allocated to one of the time groups in random permuted blocks[10]: 10 s, 30 s, 1 min, 2 min, 4 min, 7.5 min, 15 min, 30 min, 45 min and 1 h.

Once general anaesthesia had been established a cannula was placed in an antecubital vein by aseptic technique. The start time for the time interval was the most vigorous dentogingival manipulation as judged by the operator. For both the preprocedure and the postprocedure samples the blood was handled as follows: the first 0.5 ml of blood was withdrawn and discarded to void skin contaminants.[14] A further 13 ml of blood was withdrawn. Three millilitres was inoculated into BACTEC Peds aerobic and anaerobic bottles, respectively (BD, Oxford, UK). A further 6 ml was processed by lysis filtration.[15] The remaining 1 ml was frozen and stored for future polymerase chain reaction analysis.

Microbiological processing

For the BACTEC Peds, the samples were processed automatically in the BACTEC 9480 at Great Ormond Street Hospital. For the lysis filtration samples the blood was processed by a well-established method,[8] which has been shown to be reliable for detecting oral streptococci.[15] Positive cultures from both the broth culture and the lysis filtration were isolated and identified routinely by both comparative 16S rRNA and sodA gene sequencing. Negative controls were processed with every 10th run of broth culture and each run of lysis filtration to identify contamination.

Table 1 Dental disease data for the 50 patients in the 1 min postoperative sample group

	Median	Range
Age (years)	6.2	3.7–14.1
Number of teeth (primary and permanent)	20	12–28
Plaque index	14	0–76
Plaque index (partial)	4	0–37
Gingivitis index	4	0–76
Gingivitis index (partial)	1	0–26
Bleeding index	0	0–8
Sampling time (s)	21	12–36
Intensity (cfu/ml blood)	2.5	0–247

Outcome variables

Outcome variables were the percentage prevalence of positive cultures (BACTEC and lysis filtration), the intensity of bacteraemia in colony forming units per millilitre (cfu/ml) (lysis filtration), and the speciation of the organism(s) isolated (both BACTEC and lysis filtration). For the dental data, the outcome variables were the plaque index and partial plaque index, the gingivitis index and partial gingivitis index, and the number of teeth extracted per child.

Statistical analysis

The data on intensity of bacteraemia (cfu/6 ml sample) were subjected to two-way hierarchical repeated measures analysis of variance, after transformation to the fourth root so that the assumptions of the analysis were satisfied. Significant interactions indicated the need for paired *t* tests to be performed (on the fourth root of the data) to compare the pre-extraction and postextraction intensity values at each postprocedure time point, with the resulting p values adjusted for multiple testing by using the more stringent significance level of 0.01 instead of the conventional 0.05. The intensity values were summarised as medians because the raw data were highly skewed. The categorical data were subjected to conditional logistic regression analysis at each time point, from which odds ratios were estimated; these afforded comparisons of the pre-extraction and postextraction results in relation to a child having a positive culture.

RESULTS

Over 700 children constituted the preliminary sample. About 30% of parents declined to allow their child to participate. A total of 500 children participated in the study. The mean age of the children was 7.6 years (SD 2.9, range 3.4–18.9).

Variables such as age, plaque index, gingivitis index, number of teeth present at start of operation and number of teeth extracted were all similar between the various groups and did not need any special consideration during the subsequent statistical analysis.

Table 1 summarises the dental index data for the 1 min group.

Table 2 gives the intensity of bacteraemia both before and after the procedure for all groups.

Figure 1 shows a before and after graph of the duration of odontogenic bacteraemia.

Table 3 shows the odds ratios for the percentage prevalence isolation for each group.

Table 2 Intensity of bacteraemia (cfu/6 ml sample) measured by lysis filtration before and after extractions from 10 s to 1 h

Time	Before extraction		After extraction		Median of differences	p Value
	Median	Range	Median	Range		
					1.0	0.001
10 s	2.9	0–46	9.8	0–149	5.0	0.001
30 s	0.5	0–4	2.6	0–17	2.0	0.001
1 min	0.4	0–4	16.4	0–247	0	0.003
2 min	1.2	0–23	8.1	0–162	0	0.009
4 min	0.4	0–4	1.7	0–15	0	0.002
7.5 min	0.4	0–4	1.2	0–14	0	0.002
15 min	1.7	0–53	1.9	0–33	0	0.6
30 min	0.3	0–6	0.6	0–8	0	ND*
45 min	0.7	0–3	2.4	0–46	0	0.4
1 h	1.0	0–28	2.1	0–49	0	0.3

*Not determined due to lack of difference between before and after procedure values.

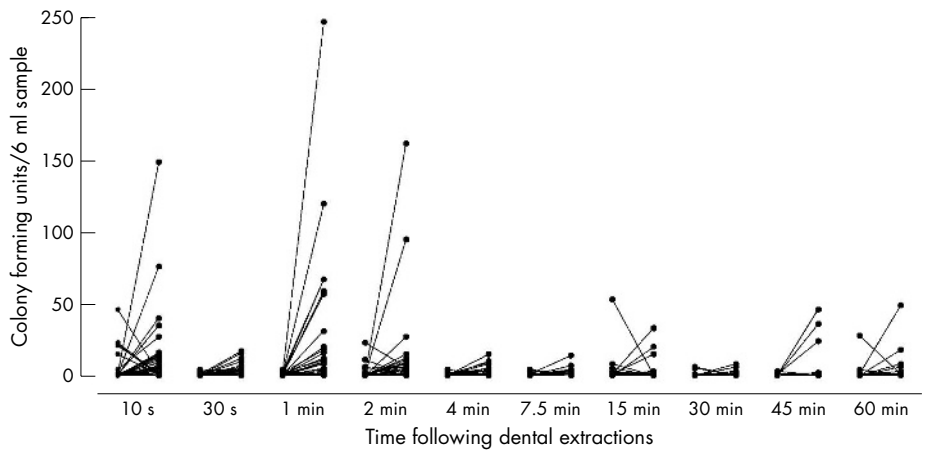

Figure 1 Ladder plot showing duration of odontogenic bacteraemia from before (left of each time unit) to after (right) dental extractions in each of 10 groups of 50 children.

Table 3 Odds ratio for percentage isolation frequency with broth culture (BACTEC Peds) for each time interval

Time	OR*	95% CI for OR	p Value
10 s	7.7	(2.30 to 25.53)	0.001
30 s	23.0	(3.10 to 170.31)	0.002
1 min	21.0	(2.83 to 156.12)	0.003
2 min	24.0	(3.24 to 177.40)	0.002
4 min	3.4	(1.48 to 7.96)	0.004
7.5 min	4.2	(3.59 to 11.14)	0.004
15 min	4.0	(1.33 to 11.96)	0.01
30 min	–	–	–
45 min	1.2	(0.52 to 2.78)	0.7
60 min	2.2	(0.76 to 6.33)	0.1

*Odds ratio of a positive culture in postextraction sample compared with pre-extraction sample.
– indicates not possible to compute.

Table 4 shows the organisms isolated from the cultures at the 1 min time interval. This is the group of most interest, as it provided the greatest intensity of bacteraemia. (A detailed analysis of microorganisms isolated at different times will be published separately.)

Table 4 Incidence of bacteria isolated in blood samples taken before and 1 min after extraction

Bacteria	Before	After
Aerobic		
Actinomyces iwolffii		1
Actinomyces meyeri		1
Actinomyces naeslundi		5
Actinomyces viscosus		1
Actinomyces spp		2
Arthrobacter spp	1	
Lactobacillus paracasei		1
Micrococus spp	7	10
Rothia dentocariosa		5
Staphylococcus capitas		1
Staphylococcus epidermidis	1	
Staphylococcus epidermidis	1	3
Staphylococcus hominis		3
Staphylococcus pasteuri		1
Stenotrophomonas maltophilia		1
Streptococcus anginosus		1
Streptococcus mitis group	1	9
Streptococcus mutans		3
Streptococcus sanguinis		2
Anaerobic		
Actinomyces naeslundi		7
Actinomyces viscosus		1
Actinomyces spp		6
Gemella morbillorum		2
Lactobacillus casei		1
Lactobacillus spp	1	1
Micrococcus spp		1
Peptostreptococcus micros		3
Propionibacterium acnes		2
Staphylococcus capitas		1
Staphylococcus epidermidis	2	4
Staphylococcus hominis	1	
Staphylococcus warneri		1
Streptococcus anginosus		3
Streptococcus gordonii		1
Streptococcus intermedius		1
Streptococcus mitis		5
Streptococcus mutans		2
Streptococcus oralis		2
Streptococcus parasanguinis		1
Streptococcus perioris		1
Streptococcus salivarius		1
Streptococcus sanguinis		2
Streptococcus sobrinus		1
Veillonella dispar		1
Veillonella spp		1

Statistical analysis of the intensity of bacteraemia data indicated that the means of the transformed data which gave the intensity values at the various postprocedure times differed significantly ($p < 0.001$). There was also a significant interaction between both the pre-extraction and post-extraction values and the postprocedure times ($p < 0.001$). Hence, paired t tests were performed for each time point, comparing the pre-extraction with the postextraction intensity values. These results showed that the intensity was significantly greater at the postextraction time than at the pre-extraction time up to and including 7.5 min; however, by 15 min and beyond, the difference was not significant (table 2).

Statistical analysis of the categorical data produced similar results, with evidence showing that the odds of having a positive culture were significantly greater in the postextraction time than in the pre-extraction time (indicated by an odds ratio that was significantly greater than 1) at each time point up to an including a postprocedure time of 7.5 min but not beyond this time (table 2).

By interpolation it is appropriate to estimate that dental bacteraemia is quenched within about 12 min of completing dental extractions.

DISCUSSION

This study, by virtue of the large number of samples in each timed group, gives a clear estimate of the duration of bacteraemia after multiple dental extractions in children. The technique of lysis filtration is much more sensitive at detecting bacteraemia than the broth culture in BACTEC.[7 15] The results in this study are similar to those of a detailed study comparing the validity of BACTEC with that of lysis filtration in the detection of dental bacteraemia.[15] For these reasons, the data from the lysis filtration were used to assess the duration of bacteraemia. This was clearly highest during and up to 7.5 min and then diminished rapidly as most of the bacteraemia had been removed by the immune defence systems within 15 min (table 2). This speed of removal is at first surprising, but a seminal paper from 1931 showed that microorganisms injected into an experimental animal are detectable in lymphoid reticular cells within 2 min.[16] The speed with which the reticuloendothelial system removes bacteria accounts for the rapid decrease of bacterial counts observed in this study. The small difference in intensity (cfu/6 ml sample) detected at 7.5 min and the non-significant difference at 15 min indicates that the duration of the bacteraemia was greater than 7.5 min and less than 15 min. It is convenient to place a figure of 11 min on the duration of bacteraemia, as this is halfway between the two timed groups, although this assumes a linear relationship.

Other factors to consider in this report are the nature of the bacterial isolates. The genera most often detected—that is, *Streptococcus, Actinomyces* and *Staphylococcus*—are similar to those found in previous studies.[6 8 17–25] The identification techniques used in this study, 16S rRNA and sodA gene sequencing, have enabled speciation of streptococci and staphylococci to a level beyond that previously reported in the literature. Only the data from 1 min after extraction have been presented in this report, as this time sample provided the greatest number of colony forming units. Further work detailing the isolates at all the time intervals studied will be the subject of a separate report. Some of the staphylococci may be contaminants, but it is not possible to identify the skin as a source of contamination without carrying out DNA typing of the isolates and matching them to skin swabs taken at the time of the blood sample. This latter procedure was not done.

The duration of bacteraemia after other procedures cannot be unequivocally given but there is no reason to suggest that it is any different from the data presented here.[9] It is

important to note that in procedures that may take some considerable time, for example, conservative dentistry (fillings), it is necessary to add the operative time to the duration of post-treatment bacteraemia, as the total duration of bacteraemia is the sum of these two elements.[26]

In conclusion, these data indicate that a postprocedure bacteraemia is quenched within 12 min.

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FROM BMJ JOURNALS

Familial hypercholesterolaemia commonly presents with Achilles tenosynovitis

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Please visit the *Heart* website [www.heartjnl.com] for a link to the full text of this article.

Background: Patients with heterozygous familial hypercholesterolaemia (HeFH) develop tendon xanthomata (TX), most commonly in their Achilles tendons. Even before tendons are chronically enlarged, tenosynovitis may occur and medical advice be sought. Untreated HeFH carries a high risk of premature coronary heart disease, which can be ameliorated by early diagnosis.

Objective: To determine the prevalence of episodes of Achilles tendon pain in HeFH before its diagnosis.

Methods: Patients with definite HeFH (Simon Broome criteria) attending a lipid clinic were identified. They completed a questionnaire asking about symptoms relating to their Achilles tendons. Unaffected spouses or cohabiting partners served as controls.

Results: 133 patients (47% men) and 87 controls (51% men) participated. TX had been recognised by the referring physicians in <5% of cases. However, 62 (46.6% (95% confidence interval (CI) 38.1 to 55.1)) patients had experienced one or more episodes of pain in one or both Achilles tendons lasting >3 days, whereas only 6 (6.9% (1.6 to 12.2)) controls had done so (difference $p<0.001$; likelihood ratio 6.75). Typically, in the patients with HeFH the pain lasted 4 days (median). It was described as severe or very severe in 24/62 (38.7% (30.4 to 47.0)) patients with HeFH, but never more than moderate in controls. 35 (26.3% (18.8 to 33.8)) patients with HeFH had consulted a doctor about Achilles tendon pain, but in no case had this led to a diagnosis of HeFH. None of the controls had consulted a doctor.

Conclusions: Measurement of serum cholesterol in patients presenting with painful Achilles tendon could lead to early diagnosis of HeFH.

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