Incidence and bacteriology of bacteremia associate with various oral and maxillofacial surgical procedures

メタデータ	言語: eng 出版者: 公開日: 2017-10-03 キーワード (Ja): キーワード (En): 作成者: メールアドレス: 所属:
URL	http://hdl.handle.net/2297/2456

Incidence and bacteriology of bacteremia associated with various oral and maxillofacial surgical procedures

Sumie Takai, DDS [a], Tomoari Kuriyama, DDS, PhD [b], Maki Yanagisawa, DDS [c], Kiyomasa Nakagawa, DDS, PhD [d] and Tadahiro Karasawa MD, PhD [e]

Department of Oral and Maxillofacial Surgery, Kanazawa University Graduate School of Medical Science, KANAZAWA, JAPAN

[a] PhD Student, Department of Oral and Maxillofacial Surgery, Kanazawa University Graduate School of Medical Science

[b] Clinical Instructor, Department of Oral and Maxillofacial Surgery, Kanazawa University Hospital

[c] PhD Student, Department of Oral and Maxillofacial Surgery, Kanazawa University Graduate School of Medical Science

[d] Associate Professor, Department of Oral and Maxillofacial Surgery, Kanazawa University Graduate School of Medical Science

[e] Professor, Department of Laboratory Sciences, School of Health Sciences, Kanazawa University

Corresponding author: Dr. Tomoari Kuriyama

Post: Department of Oral and Maxillofacial Surgery, Kanazawa University Hospital

13-1 Takara-machi, Kanazawa 920-8640, Ishikawa, Japan

Tel.: +81 (0) 76 265 2444 Fax.: +81 (0)76 234 4202

E-mail: tomkuriyama@ybb.ne.jp

Abstract

Objective. The aim of this study was to determine the incidence and bacteriology of bacteremia associated with various oral and maxillofacial surgical procedures.

Methods. A total of 237 patients who underwent oral and maxillofacial surgery were included in this study. Blood samples were obtained for bacteriological examination immediately after the essential steps of the surgical procedure had been performed.

Results. Bacteremia was detected in patients who underwent surgery for tumor, infection and trauma, and surgical reconstruction of jaw. In particular, decortication for osteomyelitis and tooth extraction resulted in a higher incidence of bacteremia compared with other surgical procedures. The incidence of bacteremia was not affected by oral hygiene, gingival inflammation, blood loss and duration of surgery. Furthermore, concerning tooth extraction, there was no statistical difference in the incidence of bacteremia with respect to the number of teeth extracted and the method of extraction. Extraction of teeth with odontogenic infection (periodontitis, periapical infection and pericoronitis) did however produce a significantly increased incidence of bacteremia compared with infection-free teeth ($P<0.01$). Viridans streptococci were the predominant group of bacteria isolated from the bacteremias.

Conclusion. Oral and maxillofacial surgery involving trans-oral incision produces bacteremia, regardless of the extent and degree of surgical invasion. In particular, surgical procedure at infected sites is more likely to result in bacteremia compared with infection-free sites.

INTRODUCTION

Dental procedures associated with significant bleeding can cause transient bacteremia [1]. Such bacteremia is a potential cause of infective endocarditis (bacterial endocarditis) in patients with congenital or acquired cardiac anomalies, and in these instances the infection can be life-threatening [1-4]. It is therefore recommended that 'at-risk' patients receiving procedures that could induce bacteremias should receive prophylactic treatment [1-4]. The American Heart Association (AHA) and the British Society of Antimicrobial Chemotherapy (BSAC) provide guidelines regarding prophylactic antibiotic prescription for dental surgical procedures such as tooth extraction, periodontal surgery, dental implant replacement and endodontic surgery [1, 2]. However, in situations of oral and maxillofacial surgery, surgical procedures performed are generally more extensive and invasive, and surgical treatment for non-odontogenic diseases are also required. Although the guidelines for prophylactic treatment in oral and maxillofacial surgery should contribute to the prevention of infective endocarditis, scientific data is not available and consequently the prophylaxis for the surgery is empirically performed [1]. Data concerning the incidence and nature of bacteremia resulting from individual surgical procedures would be important in assessing the need for prophylaxis and choice of antimicrobial regimen [4]. However, to date, there have been few studies investigating bacteremias related to oral and maxillofacial surgery.

Tooth extraction is perhaps the most frequently performed procedure in oral and maxillofacial surgery. Tooth extraction in 'at-risk' patients is covered by antimicrobial prophylaxis according to AHA and BSAC guidelines [1, 2] and the predisposing factors of bacteremia in such patients have been investigated [5-8]. Whilst these investigations contribute to more effective prevention of infective endocarditis, there have been contradictory conclusions generated by these studies.

The aim of the present study was to determine the incidence and bacteriology of bacteremia associated with various oral and maxillofacial surgical procedures. In addition, we also aimed to clarify the predisposing factors to bacteremia associated with tooth extraction.

MATERIALS AND METHODS

Patients

A total of 237 patients (127 males and 110 females; mean age, 41.0) undergoing oral and maxillofacial surgery at Kanazawa University Hospital between July 2000 and July 2004 were included in the study. Excluded patients included those who had signs of general inflammation (not associated with disease or trauma treated here), immunosuppressed patients and those receiving antibiotics or medication that might impair the immune system. Written informed-consent for this study was obtained from all patients. This study was approved by the Ethics Committee of Kanazawa University Graduate School of Medical Science.

Oral examination

Visual and radiographical examinations were undertaken to confirm patient records in relation to oral and dental status. This included the number of teeth present in the oral cavity and the presence or absence of odontogenic infection (*e.g.* caries, periodontitis, periapical diseases and pericoronitis). Gingival health and oral hygiene were assessed using the Gingival Index (GI) [9] and the Oral Hygiene Index-Simplified (OHI-S) [10], respectively. The records were made 12 h prior to start of the surgical procedure by one examiner.

Anesthesia

An endotracheal and local (infiltration) anesthesia using 2% lidocaine with 1/80000 epinephrine were used in 203 and 34 patients, respectively.

Surgical procedures and blood sampling

A 15 ml volume of venal blood was taken from the vena mediana cubiti or vena dorsale pedis of the patients using 18-G needle with disposable syringe.

In order to determine frequency of bacteremia before surgical procedure (baseline bacteremia), blood was sampled three minutes after the administration of the general or local anesthesia in 46 of the 237 patients, who were randomly selected (general anesthesia, n=23; local anesthesia, n=23).

The following procedures were performed using standard surgical methods and blood samples were taken immediately after the essential steps of the procedure had been completed.

Decortication for osteomyelitis of jaw. Twelve patients with chronic purulent osteomyelitis of the jaw received decortication. Blood samples were obtained when all infected bone marrows had been completely removed.

Tooth extraction. Due to odontogenic infection or orthodontological problem, a total of 57 patients underwent tooth extraction under general or local anesthesia. Lifting of a mucoperiosteal flap and removal of overlying bone was required to extract teeth impacted in the jaw of 30 patients. Blood samples were obtained immediately after removal of the tooth from the alveolar socket. If two or more teeth were being extracted, blood samples were obtained after completion of all extractions.

Orthognathic surgery. Bilateral sagittal split ramus osteotomy (SSRO; n=14), intraoral vertical ramus osteotomy (IVRO; n=3) and subapical osteotomy (SO; n=1) were performed for mandibular advancement or setback. Blood samples were obtained when fixation of all bone fragments with titan plates in new positions had been established (SSRO or SO cases) or the bilateral ramus had been cut (IVRO cases). A combination of LeFort I osteotomy and SSRO or IVRO was carried out to change both maxillar and mandibular positions in 15 patients. In these patients, blood samples were taken when the essential step of SSRO or IVRO (as mentioned formerly) had been completed after LeFort I osteotomy.

Surgical repair of jaw fracture. Thirteen patients had only a mandibular fracture that required surgical reposition and fixation of bone fragments. Wound infection and tooth dislocation was not evident in these patients. In all of these cases, the surgical approach was by trans-oral incision. Blood samples were obtained after all bone fragments had been fixed in the correct position.

Radical operation of the maxilla sinus. The Caldwell-Luc procedure was performed in 18 patients with chronic odontogenic maxillary sinusitis or secondary maxillary cyst associated with previous sinusitis operation (post operative maxillary cyst). Blood samples were obtained following completion of antrostomy. In all of these cases, closing the oroantral defect was not performed.

Surgical reconstruction of jaw with bone graft. In 16 patients, jaws that had previously been injured by trauma, tumor or infection were reconstructed using iliac crest

bone graft. Iliac crest bone was obtained from each patient and inserted into the defect of the jaw. Blood sample was taken when the graft was completed.

Enucleation of odontogenic cyst. Follicular (n=5) and radicular cysts (n=23) were enucleated under general anesthesia. Blood samples were taken immediately after saucerization or apicoectomy of the tooth involved (if performed) following removal of the cyst.

Surgery for oral tumor. Fifteen patients underwent excision of tumors in the tongue, soft palate or buccal mucosa (benign, n=5; malignant, n=10) by trans-oral incision approach under general anesthesia. In these patients, blood sample was taken following tumor excision.

Marginal resection of the jaw was performed to treat malignant and odontogenic benign tumors in nine patients. The jaw was reconstructed using a titan reconstruction plate after resection. Blood samples were obtained after the reconstruction plate was fixed in the jaw.

Fourteen patients with advanced oral squamous cell carcinoma were treated by a combination of marginal or partial resection of jaw and functional radical neck dissection (the tumor side). Radical neck dissection was carried out following the jaw resection and blood samples were obtained after dissection.

Reconstructive surgery using pedicle or free flap was not included in the operations.

Surgical removal of titan plates implanted in jaw. Twelve patients requested surgical removal of titan plates implanted in the jaw for treatment of fracture or jaw

deformity. The plates were surgically removed by trans-oral incision. The plates had been implanted at least six months before and exhibited no clinical sign of inflammation. Mean number of plates removed was 3.1 (Range 1-6). Blood sample were obtained when all plates implanted were removed.

Arthroscopic surgery for temporomandibular disorders (TMD). Arthroscopic surgery was performed in ten patients with TMD. Blood samples were obtained immediately after the arthroscope was removed from the temporomandibular superior joint space at termination of the surgery.

Identification of isolates from the blood sample

A 7-ml volume of the blood sample was incubated in 70 ml of Trypticase-Soy Broth (SEPTI-CHEK TSB bottle, Becton Dickinson, MA) aerobically at 37°C for three days. The remaining 8-ml volume of blood was inoculated in 70 ml of Schaedler broth (SEPTI-CHEK Schaedler bottle, Becton Dickinson) in an anaerobic atmosphere at 37°C for up to seven days. The sediment of each broth was inoculated on Brucella HK agars (Kyokuto, Tokyo, Japan) supplemented with 5% v/v sheep blood, and incubated in an aerobic, microaerophilic or anaerobic atmosphere for up to seven days at 37°C. Duplicate plates were prepared containing paromomycin (75 mg/L; Pfizer Japan, Tokyo, Japan) and vancomycin (2.5 mg/L; Shionogi, Osaka, Japan) in order to selectively isolate strictly anaerobic Gram-negative bacilli [11, 12]. Aerobic and microaerophilic bacteria were identified using conventional methods [11-14]. Rap ID ANA II (Innovative Diagnostic System, Norcross, GA) was used to identify strictly anaerobic bacteria as described previously [11, 12].

Factor predisposing to bacteremia

Relationship between incidence of positive blood culture and the OHI-S, the GI score, number of teeth presence, blood loss or duration of surgery was determined using the Chi-square test. Statistical analysis with the Chi-square test was also used to investigate whether the number of teeth extracted, method of procedure and anesthesia, and presence or absence of infection in extracted tooth was linked to the incidence of bacteremia associated with tooth extraction.

RESULTS

Baseline bacteremia

Only one of the 46 blood samples (general anesthesia, 1 of 23; local anesthesia, 0 of 23) obtained before the start of surgery was positive for bacteremia, with *Peptostreptococcus* sp. being isolated.

Incidence of bacteremia associated with oral and maxillofacial surgical procedures

Bacteremia was detected with most of the surgical procedures tested in this study (Table I). Surgery for osteomyelitis resulted in the highest prevalence of positive blood culture (58.3%), closely followed by tooth extraction (57.9%). The incidence of bacteremia in patients who underwent orthognathic surgery was not as high (30.3%). However, bacteremia occurred significantly more often in double-jaw orthognathic surgery (LeFort I osteotomy with SSRO or IVRO; 8 of 15 patients) than single-jaw surgery (SSRO, SO or IVRO; 2 of 18 patients) ($P<0.02$).

Surgical repair of jaw fracture, radical operation of the maxilla sinus (Caldwell-Luc procedure), surgical reconstruction of jaw and enucleation of odontogenic cyst resulted in 17.9-23.1% of incidence of bacteremia. In surgeries for oral tumor, excision of soft

tissue tumors resulted in a 13.3% of incidence of bacteremia although the patients who underwent resection of the jaw did not yield positive blood culture. The incidence of bacteremia resulting from surgery involving radical neck dissection was similar to those where just resection of jaw or tumor excision occurred. Positive blood culture was obtained in only one of 12 patients who underwent surgical removal of titan plates implanted. No patients who underwent arthroscopic surgery were blood culture positive.

Isolates from the blood sample

A total of 70 patients exhibited positive blood culture and the mean number of isolated species was 1.7 (range 1-7). Viridans streptococci were commonly isolated, with 36 (51.4%) of the 70 patients yielding this microorganism. Strict anaerobes such as *Actinomyces* sp. and *Prevotella* sp. were also isolated frequently (Table II). There was no noticeable difference in the bacteriology of bacteremia between the surgical procedures (data not shown).

Relationship between incidence and various factors: bacteremia associated with oral and maxillofacial surgical procedures

Neither the OHI-S nor GI score appeared relevant to the incidence of bacteremia (Table III). There was no correlation between incidence of bacteremia and the number of teeth present (Table III) whilst positive blood culture was not obtained in toothless patients. Incidence of bacteremia did not correlate with blood loss. Although surgical procedures of less than 30 min revealed a significantly higher incidence of bacteremia than longer duration procedures ($P<0.05$), there was little difference in the incidence of bacteremia with respect to duration of procedure in patients that exceeded 30 min.

Relationship between incidence and various factors: bacteremia associated with tooth extraction

There was not an obvious relationship between the incidence of bacteremia and the number of teeth extracted (Table IV). The incidence of bacteremia caused by tooth extraction requiring bone removal did not statistically differ compared with that of simple tooth extraction procedure. However, extraction of teeth with odontogenic infection (periodontitis, periapical infections and pericoronitis) resulted in a significantly higher incidence of bacteremia than that of the infection-free teeth ($P<0.01$).

There was no statistical difference in the incidence of bacteremia in patients undergoing general or local anesthesia.

DISCUSSION

In this study, only one patient exhibited a positive blood culture obtained before the start of the operation. This low baseline incidence would therefore support the argument of the surgical procedure being the cause of any subsequent bacteremia.

Bacteremia was often detected in patients who underwent surgery for purulent osteomyelitis (Table I). This would support the belief that surgical procedure at infected sites is more likely to produce bacteremia [4].

High incidence of post-tooth extraction bacteremia (43.1-100%) has been demonstrated [5-8]. In this study, tooth extraction also resulted in a high incidence of bacteremia (57.9%). Tooth extraction has the highest risk of bacteremia in oral and maxillofacial procedures although this would be rather less physically stressful for patients compared to other procedures described here.

Bacteremia was detected in 30.3% of the patients who underwent orthognathic surgery (Table I). Interestingly, there was a significant difference in the incidence of

bacteremia between single-jaw and double-jaw surgeries (P<0.02). Double-jaw orthognathic surgery is more likely to produce bacteremia than single-jaw surgery although the reason for this requires further study.

Caldwell-Luc procedures did not produce bacteremia as often as surgery for osteomyelitis. In this study, no patient with odontogenic maxillary sinusitis or maxillary cyst associated with previous sinusitis operation exhibited any acute inflammation sign or symptom, and therefore it is deemed that there was not much bacterial growth at the operation site. It has been suggested that chronic sinusitis is not a bacterial disease but rather the result of chronic inflammation produced by a previous acute inflammation [15]. The low incidence of bacteremia presented here would be relevant to such sinus condition and/or the etiology of chronic sinusitis.

This study demonstrates that surgical repair of jaw fracture, surgical reconstruction of jaw with bone graft, enucleation of odontogenic cyst and removal of titan plates implanted in jaw can produce bacteremia although the frequency is not high. Surgery for oral tumor also appeared to produce bacteremia. Incidence of bacteremia caused by surgery including radical neck dissection did not notably differ from just local tumor excision or resection. Moreover, in the surgical procedures for tumor and cyst, incidence of bacteremia did not correlate with either extent of surgery or size of lesion (data not shown). Extent of surgery did not appear to be associated with development of bacteremia.

Arthroscopic surgery for TMD resulted in no occurrence of bacteremia. This procedure was not performed through trans-oral incision but by trans-skin incision. The oral mucosa has a heavier bacterial flora than the skin. Moreover, there are generally very few bacteria that generally colonize the temporomandibular joint. Such an operation method and/or operation site condition is therefore not surprisingly associated

with the absence of subsequent bacteremia. In contrast with other procedures presented here, this procedure would not need to be covered by antimicrobial prophylaxis.

Viridans streptococci and strict anaerobes such as *Actinomyces* sp. and *Prevotella* sp. were the predominant isolates in this study (Table II). These bacterial species could reside in the oral cavity as members of the commensal bacterial flora [14], and are reported to be involved in infective endocarditis [16, 17]. The present bacteriology data is similar to that of bacteremia associated with dental procedure reported previously [5-8].

This study determined the incidence of bacteremia with relation to the number of teeth present. The incidence of bacteremia in patients with teeth was 23.1-43.8%, and there was no particular association between tooth number and incidence of bacteremia (Table III). However, bacteremia was not detected in toothless patients. It is possible that composition of oral bacterial flora in edentulous patients is different from that in toothed patients because of no periodontal pocket and dental plague. Although further study is necessary, the risk of bacteremia associated with oral and maxillofacial procedures would be lower in toothless patients compared with toothed patients.

In this study, neither gingival inflammation nor oral hygiene affected the occurrence of bacteremia. These findings would suggest that the level of oral hygiene care is not a direct risk factor for bacteremia associated with surgery.

The majority of procedures that took less than 30 min generally involved tooth extraction (data not shown). This would be relevant to a high incidence of bacteremia in these patients. It is worth noting that there was little difference in the incidence of bacteremia with respect to duration of procedure in patients that exceeded 30 min. Moreover, incidence of bacteremia did not correlate with blood loss. These findings suggest that the degree of surgical invasion is not relevant to subsequent incidence of bacteremia. Application of antimicrobial prophylaxis should not therefore be dependent

on the extent and likely invasion degree of procedure.

Since tooth extraction is commonly performed on a clinical basis and appeared to produce bacteremia frequently, this study investigated whether the number and status of teeth extracted correlated with incidence of bacteremia. In contrast with previous studies [5, 7], there was no obvious relationship in the number of teeth extracted and the incidence of bacteremia (Table IV). Moreover, there was no statistical difference in the incidence of bacteremia according to whether the procedure involved removal of bone. It is likely that the method of extraction procedure is not an influencing factor on the occurrence of bacteremia. Interestingly, extraction of teeth with periodontitis, pericoronitis or periapical infection produced bacteremia significantly more often than teeth without infection ($P<0.01$). It is possible that bacteria that could invade into the blood stream by surgical procedure are present around infected teeth at a greater level compared with infection-free teeth, and consequently, such bacterial growth might be associated with high incidence of bacteremia in patients undergoing extraction of infected teeth. Obviously therefore, the presence of such infections would increase the subsequent risk of bacteremia.

Whether prophylactic antibiotics really prevent infective endocarditis still remains unclear. However, since it has been demonstrated that antibiotics reduce the prevalence and magnitude of bacteremia, the administration of an antibiotic prophylactic to ‘at-risk’ patients who are undergoing certain dental manipulations including tooth extraction has been widely accepted. [16] The results of the present study would suggest that antibiotic prophylaxis for oral and maxillofacial surgical procedures involving trans-oral incision in 'at-risk' patients is recommended even if the procedures are not highly invasive or extensive. Although further study is necessary to establish a prophylactic antibiotic regimen for the surgical procedures, the AHA and BSAC regimens for dental procedures

might be applicable due to similar bacteriology of bacteremia.

Acknowledgements

We thank all patients who kindly contributed to this study. We are grateful to Dr. D.W. Williams (Cardiff University, Cardiff, UK), Miss K. Iwahara, Dr. H. Araki, Professor E. Yamamoto (Department of Oral and Maxillofacial Surgery, Kanazawa University Graduate School of Medical Science) and all members of our department for their advice and kind cooperation. We wish to acknowledge Dr. T. Nishimura (Department of Otolaryngology, Kanazawa University Hospital) for the helpful suggestions regarding aspects of otolaryngology.

REFERENCES

1. Dajani AS, Taubert KA, Wilson W, Bolger AF, Bayer A, Ferrieri P, et al. Recommendations by the American Heart Association. JAMA 1997; 277: 1794-801.
2. Simmons NA. Recommendations for endocarditis prophylaxis. The Endocarditis Working Party for Antimicrobial Chemotherapy. J Antimicrob Chemother 1993; 31:437-8.
3. Roberts GJ. Dentists are innocent! "Everyday" bacteremia is the real culprit: a review and assessment of the evidence that dental surgical procedures are a principal cause of bacterial endocarditis in children. Pediatr Cardiol 1999; 20:317-25.
4. Hall G, Heimdahl A, Nord CE. Bacteremia after oral surgery and antibiotic prophylaxis for endocarditis. Clin Infect Dis 1999; 29:1-8.
5. Roberts GJ, Watts R, Longhurst P, Gardner P. Bacteremia of dental origin and antimicrobial sensitivity following oral surgical procedures in children. Pediatr Dent 1998; 20:28-36.
6. Coulter WA, Coffey A, Saunders ID, Emmerson AM. Bacteremia in children following dental extraction. J Dent Res 1990; 69:1691-5.
7. Okabe K, Nakagawa K, Yamamoto E. Factors affecting the occurrence of bacteremia associated with tooth extraction. Int J Oral Maxillofac Surg 1995; 24:239-42.
8. Heimdahl A, Hall G, Hedberg M, Sandberg H, Soder PO, Tuner K, et al. Detection and quantitation by lysis-filtration of bacteremia after different oral surgical procedures. J Clin Microbiol 1990; 28:2205-9
9. Loe H, Silness J. Periodontal disease in pregnancy, I. Prevalence and severity. Acta

Odontol Scand 1963; 21: 533-51.

10. Greene JC, Vermillion JR. The simplified oral hygiene index. J Am Dent Assoc 1964; 68:7-13.
11. Kuriyama T, Karasawa T, Nakagawa K, Saiki Y, Yamamoto E, Nakamura S. Bacteriologic features and antimicrobial susceptibility in isolates from orofacial odontogenic infections. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000; 90:600-8.
12. Kuriyama T, Karasawa T, Nakagawa K, Yamamoto E, Nakamura S. Incidence of β-lactamase production and antimicrobial susceptibility of anaerobic gram-negative rods isolated from pus specimens of orofacial odontogenic infections. Oral Microbiol Immunol 2001; 16:10-5.
13. Kuriyama T, Karasawa T, Nakagawa K, Yamamoto E, Nakamura S. Bacteriology and antimicrobial susceptibility of gram-positive cocci isolated from pus specimens of orofacial odontogenic infections. Oral Microbiol Immunol 2002; 17:132-5.
14. Murray PR, Baron EJ, Pfaller MA, Tenover FC, Yolken RH. Manual of Clinical Microbiology. 7th ed. Washington DC: American Society for Microbiology, 1999.
15. Rontal M, Bernstein JM, Rontal E, Anon J. Bacteriologic findings from the nose, ethmoid, and bloodstream during endoscopic surgery for chronic rhinosinusitis: implications for antibiotic therapy. Am J Rhinol. 1999; 13:91-6.
16. Carmona IT, Diz Dios P, Scully C. An update on the controversies in bacterial endocarditis of oral origin. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002; 93:660-70.
17. Barco CT. Prevention of infective endocarditis: a review of the medical and dental literature. J Periodontol 1991; 62:510-23.

Table I. Incidence of bacteremia associated with various oral and maxillofacial surgical procedures

Surgical procedure	No. of bacteremic patients/ No. of total patients (%)
Decortication for jaw osteomyelitis	7/12 (58.3)
Tooth extraction	33/57 (57.9)
Orthognathic surgery	10/33 (30.3)
Surgical repair of jaw fracture	3/13 (23.1)
Caldwell-Luc procedure	4/18 (22.2)
Surgical reconstruction of jaw with bone graft	3/16 (18.8)
Enucleation of odontogenic cyst	5/28 (17.9)
Surgery for oral tumor	
Resection of jaw and radical neck dissection	2/14 (14.3)
Excision of tumor in soft tissue	2/15 (13.3)
Resection of jaw	0/ 9 (0)
Surgical removal of titan plates implanted in jaw	1/12 (8.3)
Arthroscopic surgery for TMD	0/10 (0)

Table II. Identity of isolates from bacteremia associated with oral and maxillofacial surgical procedures

Bacteria	No. of isolates
Streptococcus	36
Actinomyces	18
Prevotella	13
Veillonella	10
Peptostreptococcus	7
Haemophilus	6
Fusobacterium	5
Enterococcus	3
Corynebacterium	2
Porphyromonas	1
Lactobacillus	1
Neisseria	1
Staphylococcus	1
Micrococcus	1
Propionibacterium	1
Unidentified aerobic Gram-positive bacilli	9
Unidentified aerobic Gram-negative bacilli	2
Unidentified anaerobic Gram-negative bacilli	3

Table III. Relationship between incidence and various factors: bacteremia associated with oral and maxillofacial surgical procedures

Factor	Value	No. of bacteremic patients / No. of total patients (%)
GI (score) *	0 - 0.49	26 / 76 (34.2)
	0.5 - 0.99	2 / 22 (9.1)
	1.0 - 1.49	23 / 70 (32.9)
	1.5 - 1.99	7 / 23 (30.4)
	2.0 - 2.49	10 / 31 (32.3)
	2.5 -	2 / 6 (33.3)
OHI-S (score) *	0 - 0.49	24 / 79 (30.4)
	0.5 - 0.99	21 / 59 (35.6)
	1.0 - 1.49	11 / 38 (28.9)
	1.5 - 1.99	4 / 23 (17.4)
	2.0 - 2.49	1 / 8 (12.5)
	2.5 - 2.99	5 / 10 (50)
	3.0 -	4 / 11 (36.4)
No. of teeth present	0	0 / 9 (0)
	1 - 4	1 / 4 (25)
	5 - 9	2 / 6 (33.3)
	10 - 14	3 / 13 (23.1)
	15 - 19	7 / 21 (33.3)
	20 - 24	14 / 32 (43.8)
	25 - 28	43 /152 (28.3)
Blood loss (g)	- 99	51 /161 (31.7)
	100 - 199	8 / 34 (23.5)
	200 - 299	4 / 15 (26.7)
	300 -	7 / 27 (25.9)
Duration of procedure (min) †	- 29	15 / 31 (48.4) ‡
	30 - 59	19 / 70 (27.1)
	60 - 89	12 / 42 (28.6)
	90 -	24 / 94 (25.5)

* Not applied in nine toothless patients.

† Time from start of incision to completion of essential steps of procedure.

‡ $P<0.05$ vs. procedures taking 30-59 min and exceeding 90 min.

Table IV. Relationship between incidence and various factors: bacteremia associated with tooth extraction

Factor	Value	No. of bacteremic patients / No. of total patients (%)
No. of teeth extracted	1	11 / 25 (44)
	2	11 / 16 (68.8)
	3	5 / 7 (71.4)
	4	3 / 5 (60)
	≥5	3 / 4 (75)
Method of procedure	Simple procedure	17 / 27 (63.0)
	Procedure for impacted tooth †	16 / 30 (53.3)
Infection in extracted tooth*	Presence	30 / 44 (68.2) ‡
	Absence	3 / 13 (23.1)
Anesthesia for procedure	General	15 / 26 (57.7)
	Local	18 / 31 (58.1)

* Periodontitis, periapical infection and pericoronitis.

† Procedure requiring lifting of a mucoperiosteal flap and removal of overlying bone.

‡ $P < 0.01$ vs. infection free teeth.