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Original Article

Viridians Group Streptococci in Patients Undergoing Tooth Extraction

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ABSTRACT

The aerobic microflora of the oral cavity consists of viridians group of streptococci (VGS). The present study was carried out with an objective to evaluate the prevalence of VGS in patients undergoing tooth extraction and to study their antibiotic susceptibility pattern. Samples of subgingival dental plaques for microbiological studies were collected from 80 patients undergoing tooth extraction. The isolated streptococci were identified along with their antibacterial susceptibilities by automated Vitek 2 (bioMérieux) system in accordance with CLSI standards. A total of 260 VGS strains belonging to 05 phenotypic groups, namely mutans, salivarius, anginosus, sanguinus and mitis groups; along with few strains of Granulicatella like G. adiacens and G. elegans. Altogether a total of 15 species were isolated from the subgingival plaque of 80 patients undergoing tooth extraction. Among the 15 antibiotics tested, highest resistance was observed to lincosamides (36.2%) followed by macrolides (29.7%), tetracyclines (17.7%), cephems (15.1%), fluoroquinolones (14.4%), oxazolidinones (13.5%), streptogramins (12.7 %) and penicillins (7.9%). However, all the 260 VGS strains were found susceptible to vancomycin and linezolid. In the subgingival plaque of patients undergoing tooth extraction, approximately 70% of streptococci belonged to three VGS groups, i.e. mitis, sanguinis and mutans groups. Streptococci of salivarus and anginosus groups were isolated sporadically (5%). Highest resistance was observed to lincosamides and macrolides (29.7%). Multiple antibiotic resistance was observed in mitis and salivarius group.

Key words: *Viridians group streptococci, tooth extraction, antimicrobial drug resistance*

Diş Çekimi Yapılan Hastalarda Streptekok Viridans Grupları

ÖZET

Ağız boşluğu aerobik mikroflorası streptokok viridians grubundan (VGS) oluşur. Bu çalışmada diş çekimi yapılan hastalarda VGS sıklığını değerlendirmek ve onların antibiyotik duyarlılık paterni incelemek için gerçekleştirildi. Mikrobiyolojik çalışmalar için subgingival diş plaklarının örnekleri diş çekimi uygulanan 80 hastadan toplanmıştır. İzole streptokokların antibakteriyel duyarlılığı CLSI standartlarına uygun olarak otomatik Vitek 2 (bioMerieux) sistem tarafından tanımlanmıştır. 05 fenotipik gruplara ait 260 VGS suşu G. adiacens ve G. elegans gibi Granulicatella birkaç suşları ile birlikte mutans, salivarius, anginosus, sanguinus ve mitis olarak adlandırılmıştır. 15 türün tümü diş çekimi uygulanan 80 hastanın subgingival plaklarından izole edilmiştir. 15türün antibiyotik testleri arasında en yüksek direnç oranı makrolid %29.7, tetrasiklin %17.7, sefalosporin %15.1, fluorokinolon %14.4, oksazolidinon %13.5, streptogramin %12.7, linkozamidlere %36.2 ve penisilinlere % 7.9 gözlenmiştir. Ancak, tüm 260 VGS suşlarında vankomisin ve linezolid duyarlı bulunmuştur. Diş çekimi uygulanan hastaların subgingival plaklarında streptokokların yaklaşık % 70'i üç VGS grubuna (mitis, sanguinis ve mutans grupları) aitti. Salivarus ve anginosus streptokok grupları sporadik olarak % 5 elde edildi. En yüksek direnç linkozamidler ve makrolidlerde (% 29.7) gözlenmiştir. Çoklu antibiyotik direnci mitis ve salivarius grubunda gözlendi.

Anahtar kelimeler: *Viridians grup streptokoklar, diş çekimi, antimikrobiyal ilaç direnci*

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INTRODUCTION

The aerobic microflora of the oral cavity consists predominantly of viridans group streptococci (VGS), which play an important role in inhibiting colonization of pathogens (1). The largest biomasses of oral bacteria in the mouth exist on the teeth, (dental plaque), which can accumulate up to 1011 organisms per gram wet weight (2). Species of VGS including Streptococcus gordonii, Streptococcus intermedius, Streptococcus oralis and Streptococcus sanguinis, which are normally associated with healthy oral sites, are also associated with pathogens such as, Porphyromonas gingivalis, Treponema denticola and Prevotella intermedia in periodontal disease (3). It is therefore essential to gain a complete understanding of VGS, which are associated with periodontal disease process and systemic infections such as infective endocarditis. Considering this dual relationship of VGS in health and disease, it is better to define its role in the oral cavity.

VGS are often considered to be contaminants when isolated from blood cultures, where they may be found as transients in the bloodstream (4-6). However, their presence may be associated with infective endocarditis, especially in patients with prosthetic heart valves, where S. sangunius, S. mitis, S. oralis and S. gordonii being frequently isolated (4, 7). Members of the mutans group streptococci are associated with dental caries in humans and animals, where S. mutans and S. sobrinus being the species most frequently isolated from carious lesions and dental plaques. Other VGS have been reported to be associated with deep abscesses notably in the liver and brain (8), female genital tract infections (6), non-intravenous drug users with native valve infective endocarditis (4, 9, 10) and septicaemia in patients with haematological diseases who receive chemotherapy, and develop neutropenia (4, 9, 11-13). Complications associated with bacteremia in these patients include endocarditis, acute respiratory distress syndrome (ARDS) and shock (6, 11, 14). With antibiotic prophylaxis, especially with ciprofloxacin, a significant reduction in Gram negative septicaemia has been observed, but at a same time, an increase in the episodes of septicaemia caused by VGS hsa been noted (10, 15). Several studies have found reduced susceptibility to penicillin in VGS from such patients (10, 13, 15, 16), with the frequency of penicillin resistance (MIC>2.0 mg/L) in isolates of VGS being as high as >40% (17). However, recent studies have indicated that VGS are increasingly becoming resistant to many antibiotics not only to penicillin, but also to macrolides and others (6, 18, 10, 13, 15-17).

The present study was carried out to evaluate the prevalence of oral VGS in the patients undergoing tooth extraction and studying the rate of subgingival carriage of drug-resistant VGS. To the best of our knowledge, this is one of the first comprehensive studies evaluating resistance to all major oral antibiotic groups in VGS isolates from patients undergoing tooth extraction.

MATERIALS AND METHODS

Sample collection

This study was approved by the ethical committee of the Ashwini Rural Medical College, Hospital and Research Centre, Solapur, India. The study included a prospective microbiological analysis of subgingival plaque before tooth extraction. We excluded patients if they had fewer

Table 1. *Demographic and clinical characteristics of patients with and without periodontitis undergoing tooth extraction*

Demographic & Clinical characteristics	*Patients without PDD n (%)*	*Patients with PDD n (%)*	*Total n (%)*
	46 (57.5)	*34 (42.5)*	*80 (100)*
Age	*49.6±3.9*	*49.9±3.7*	*49.8±3.8*
Male	*15(18.8 %)*	*22(27.5%)*	*37(46.3%)*
Female	*31 (38.8 %)*	*12(15.0 %)*	*43 (53.8%)*
Clinical parameters (mean ± SD)			
CAL	*1.9±0.3*	*6.9±2.3 **	
PD	*1.4±0.3*	*4.8±2.4 **	
G I	*0.8±0.4*	*2.13±0.7 **	
PBI	*1.1±0.6*	*2.38±0.2**	
P I	*0.6±0.6*	*2.23±0.3**	

*Abbreviations: PDD- periodontitis , PD- probing pocket depth, * P < 0.001 compared with patients without periodontitis.*

***Table 2**. Seven groups of VGS isolated from subgingival plaque of patients undergoing tooth extraction (n:260)*

VGS strain isolated	n	%
Mitis Group		
Streptococcus mitis	50	(19.2)
Steptococcus oralis	45	(17.3)
Mutans Group		
Streptococcus mutans	30	(11.5)
Anginosus Group		
Streptococcus anginosus	6	(2.3)
Streptococcus constellatus	7	(2.7)
Sanguinius Group		
Streptococcus sanguinius	41	(15.8)
Streptococcus parasanguninis	12	(4.6)
Streptococcus gordonii	4	(1.5)
Salivarius group		
Streptococcus hyointestinalis	1	(0.4)
Undifferentiated Streptococci		
Streptococcus pluranimalium	1	(0.4)
Streptococcus sinensis	2	(0.8)
Streptococcus thoraltensis	1	(0.4)
Streptococcus tigurinus	1	(0.4)
(Nutritionally Variant Streptococci) recently classified as new genus Granulicatella		
Granulicatella adiacens	21	(8.1)
Granulicatella elegans	38	(14.6)
Total isolates	260	(100)

than 10 teeth; an active viral infection, poorly controlled systemic disease, penicillin allergy, antimicrobial usage within three months prior dental treatment, temperature greater than 100.5°F or facial cellulitis; or were immune-compromised by virtue of disease or medications. All participants provided written informed consent. In this study, 80 patients (34 with periodontitis and 46 without periodontitis) undergoing tooth extraction were screened, demographic information and medical histories from the participants were obtained and thorough clinical and radiographic examinations of their teeth were conducted. Assessment of periodontal status was performed by means of clinical attachment loss (CAL), probing pocket depths (PPD), which was measured to the nearest whole millimetre at six sites per tooth by using a William's periodontal probe. Dental indices such as, papillary bleeding index (PBI) (19), plaque index (PI) (20), and gingival index (GI) (21), were also assessed. All assessments were done by a single trained examiner. Subgingival plaque samples of the tooth were collected from the gingival area of buccal and lingual tooth surfaces of affected tooth using sterile curettes into sterile transport media.

Microbiological analysis

The samples were processed for isolation of VGS. Cultures with bacterial growth were Gram stained and subcultured onto special media, Tryptone soya blood agar supplemented with strepto supplement (Nalidixic acid 3.750 mg, Nemomycin sulphate 1.060 mg and Polymixin B sulphate 8500 units for 500 ml media) and Mutans Sanguis agar (HiMedia Laboratories, Mumbai, India). Cultures with growth were further subjected to standard biochemical identification using automated Vitek 2 (bioMérieux, Paris, France) system, to complete the strain identification. Antimicrobial susceptibilities were measured in MIC by automated Vitek 2 (bioMérieux, Paris, France) system in accordance with clinical laboratory standard institutes (CLSI) (22).

***Table 3**. Antibiotic susceptibility pattern of VGS (n=260), isolated from subgingival plaque of patients undergoing tooth extraction*

Antimicrobial	Resistant		Intermediate		Susceptible)	
	n	%	n	%	n	%
Penicillin G	24	(9.2)	(55)	21.2	181	(69.6)
Ampicillin	17	(6.5)	35	(13.5)	208	(80.0)
Cefepime	33	(12.7)	0	(0.0)	227	(87.3)
Cefotaxime	55	(21.2)	1	(0.4)	204	(78.5)
Ceftriaxone	30	(11.5)	24	(9.2)	206	(79.2)
Vancomycin	0	(0.0)	0	(0.0)	260	(100)
Erythromycin	121	(46.5)	17	(6.5)	122	(46.9)
Azithromycin	111	(42.7)	0	(0.0)	149	(57.3)
Clarithromycin	46	(17.7)	18	(6.9)	196	(75.4)
Tetracycline	46	(17.7)	6	(2.3)	208	(80.0)
Levofloxacin	45	(17.3)	1	0.4	214	(82.3)
Ofloxacin	30	(11.5)	1	(0.4)	229	(88.1)
Clindamycin	94	(36.2)	0	(0.0)	166	(63.8)
Quinupristin/Dalfopristin	33	(12.7)	0	(0.0)	226	(86.9)
Linezolid	0	(0.0)	0	(0.0)	260	(100)

Table 4. Antibiotic resistance pattern of VGS (n=260)

VGS species	n	Antimicrobial Resistance n (%)												
		PEN	AMP	FEP	CTX	CRO	VAN	ERY	AZM	CLR	TCY	LVX	OFX	CLI	QDA	LNZ
Mitis Group																
S. mitis	50	9(18)	6(12)	8(16)	16(32)	14(28)	0(0)	31(62)	32(64)	11(22)	15(30)	13(26)	5(10)	23(46)	12(24)	0(0)
S. oralis	45	7 (16)	4(9)	6(13)	11(24)	7(16)	0(0)	25(56)	30(67)	9(20)	11(24)	6(13)	4(9)	21(47)	9(20)	0(0)
Sanguinis Group																
S. sanguinis	41	4 (10)	5 (12)	4 (10)	9 (22)	3 (7)	0 (0)	27 (66)	8 (20)	7 (17)	4 (10)	6 (15)	5 (12)	12 (29)	4 (10)	0 (0)
S. parasanguinis	12	0 (0)	0 (0)	1 (8)	1 (8)	0 (0)	0 (0)	2 (17)	3 (25)	1 (8)	1 (8)	1 (8)	1 (8)	2 (17)	0 (0)	0 (0)
S. gordonii	4	0 (0)	0 (0)	1 (25)	2 (50)	0 (0)	0 (0)	3 (75)	1 (25)	2 (50)	1 (25)	1 (25)	2 (50)	1 (25)	0 (0)	0 (0)
Anginosus Group																
S. anginosus	6	0 (0)	0 (0)	0 (0)	2 (33)	0 (0)	0 (0)	1 (17)	2 (33)	1 (17)	0 (0)	3 (50)	1 (17)	1 (17)	0 (0)	0 (0)
S. constellatus	7	0 (0)	0 (0)	1 (14)	1 (14)	1 (14)	0 (0)	2 (29)	2 (29)	0 (0)	1 (14)	0 (0)	2 (29)	2 (29)	0 (0)	0 (0)
Mutans Group																
S. mutans	30	2 (7)	0 (0)	3 (10)	3 (10)	1 (3)	0 (0)	9 (30)	9 (30)	4 (13)	4 (13)	3 (10)	4 (13)	11 (37)	1 (3)	0 (0)
Salivarius Group																
S. hyointestinalis	1	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Undifferentiated Streptococci																
S. sinensis	2	0 (0)	0 (0)	1 (50)	2 (100)	0 (0)	0 (0)	2 (100)	2 (100)	2 (100)	0 (0)	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)
S. pluranimalium	1	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)	1 (100)	1 (100)	0 (0)	1 (100)	1 (100)	1 (100)	0 (0)	0 (0)
S. thoraltensis	1	0 (0)	1 (100)	1 (100)	1 (100)	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
S. tigurinus	1	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
(Nutritionally Variant Streptococci) recently classified as new genus Granulicatella																
G. adiacens	21	1 (5)	0 (0)	2 (10)	2 (10)	1 (5)	0 (0)	4 (19)	4 (19)	4 (19)	4 (19)	4 (19)	2 (10)	6 (29)	0 (0)	0 (0)
G. elegans	38	1 (3)	0 (0)	5 (13)	5 (13)	2 (5)	0 (0)	14 (37)	17 (45)	4 (11)	5 (13)	6 (16)	3 (8)	14 (37)	7 (18)	0 (0)

Abbreviations: PEN- penicillin, AMP- ampicillin, FEP- cefepime, CTX- cefotaxime, CRO- ceftriaxone VAN- vancomycin, ERY- erythromycin, AZM- azithromycin, CLR- clarithromycin, TCY- tetracycline, LVX- levofloxacin , OFX-ofloxacin, CLI- clindamycin, QDA- Quinupristin/Dalfopristin, LNZ-Linezolid

RESULTS

The amount of plaque accumulation (PI) showed statistically significant difference (P<0.001) between the patients with periodontitis and the patients without periodontitis (Table1). A highly significant difference in CAL and PD (P<0.001) was observed between the periodontitis and the patients without periodontitis. So also, the evaluation of PBI and GI in the two groups showed that there were significant differences between them (P<0.001) indicating gingival inflammation was more in periodontitis patients (Table 1). However, there was no statistically significant difference in distribution of age and sex between these two groups (Table 1).

A total of 260 VGS strains belonging to 05 phenotypic groups, along with few strains of Granulicatella species like G. adiacens and G. elegans (formerly known as the nutritionally variant streptococci) and few strains of undifferentiated Streptococci were isolated. Majority of isolates belonged to mitis group 95 (36%), followed by nutritionally variant streptococci (Granulicatella species) 59 (23%) and sanguinius group 57 (22%). Altogether a total of 15 species were isolated from the subgingival plaque of 80 patients undergoing tooth extraction (Table 2). Amongst the nine antimicrobial classes tested, highest resistance was observed to lincosamides (36.2%), followed by macrolides (29.7%), tetracyclines (17.7%), cephems (15.1%), fluoroquinolones (14.4 %), streptogramins (12.7 %) and penicillins (7.9%). However, all the 260 strains were found susceptible to vancomycin and linezolid (Chart No.1). Out of 260 strains of VGS, high rate of resistance was seen to erythromycin, azithromycin, and clindamycin. Erythromycin resistance (MIC > or = 2.0 µg/ml) was shown by 121(46.5%) strains, majority of strains were S. sinensis 2 (100%), S. pluranimalium 1(100%), S. sanguinius 27 (66%), S. mitis 31 (62%) and S. oralis 25 (56%). Azithromycin resistance (MIC > or = 2.0 µg/ml), was shown by 111 (42.7%) strains, majority of which belonged S. sinensis 2 (100%), S. pluranimalium 1(100%), S. oralis 30 (67 %), S. mitis 32

***Table 5**. In vitro activities of 15 antimicrobial agents versus 260 subgingival plaque isolates of VGS*

Antimicrobial agent	No. (cumulative %) of isolates for which the MIC (µg/ml) is as follows:										% R (Breakpoint)[a]
	0.6	0.12	0.25	0.5	1	2	4	8	16	>=32	
Penicillin G	29(11)	153(59)	18(7)	20(8)	15(6)	2(1)	4(2)	11(4)	6(2)	2(1)	9.2 (>4)
Ampicillin	45(17)	57(22)	106(41)	12(5)	9(3)	9(4)	5(2)	12(5)	4(2)	1(.4)	6.5 (>=8)
Cefepime		46(18)	60(23)	60(23)	61(23)		25(10)	5(2)	3(1)		12.7 (>=4)
Cefotaxime		45(17)	58(22)	87(34)	14(5)	1(.4)	16(6)	22(9)	11(4)	6(2)	21.2 (>=4)
Cefitriaxone		54(21)	46(18)	58(22)	49(19)	24(9)	12(5)	11(4)	6(2)		11.5 (>=4)
Vancomycin	27(10)	43(17)	46(18)	54(21)	90(35)						-/-
Erythromycin	17(7)	45(17)	60(23)	17(7)	19(7)	47(18)	24(9)	11(4)	14(5)	6(2)	46.5 (>=1)
Azithromycin	15(6)	12(5)	57(22)	65(25)		44(18)	38(15)	27(10)	2(1)		42.7 (>=2)
Clarithromycin	63(24)	66(25)	67(26)	18(7)	29(11)	14(5)	3(1)				17.7 (>=1)
Tetracycline		25(10)	37(14)	43(17)	50(19)	53(20)	6(2)	26(10)	18(7)	2(1)	17.7 (>=8)
Levofloxacin		26(10)	73(28)	77(30)	30(12)	8(3)	1(.4)	30(12)	12(5)	3(1)	17.3 (>=8)
Ofloxacin		20(8)	79(30)	79(30)	33(13)	19(7)	1(.4)	18(7)	9(3)	2(1)	11.5 (>=8)
Clindamycin	58(22)	67(26)	41(16)		52(20)	35(14)	4(2)	3(1)			36.2 (>=1)
Quinupristin/Dalfopristin	16(6)	60(23)	46(18)	54(21)	51(20)		21(8)	12(5)			12.7 (>=4)
Linezolid	25(10)	44(17)	49(19)	25(10)	31(12)	86(33)					-/-

a MIC breakpoints for resistance are those recently defined by CLSI for viridans group streptococci.

(64%) and G. elegans 17 (45%). Similarly clindamycin resistance (MIC > or = 1.0 µg/ml) was shown by 94 (36.2%) strains, majority of strains were S. oralis 21 (47%), S. mitis 23 (46%), S. mutans 11 (37%) and G. elegans 14 (37%). However, low level of resistance was seen to ampicillin17 (6.5%) and penicillin 24 (9.2%). Resistance to penicillin (MIC > or = 4 µg/ml) was observed only in S. mitis (18%), S. oralis (16%),S. sanguinis (10%) , S. mutans (7%), G. adiacens (5%) and G. elegans (3%) and all the remaining strains of VGS were susceptible to penicillin. (Table 3, 4, Chart 1, 2).

Out of the 260 isolates, 103 (40%) VGS strains were uniformly susceptible to all 15 antimicrobials, G. elegans (38%) was the predominant isolate amongst the susceptible VGS isolates. Resistance profile analysis showed 28 (11%) VGS isolates resistant to as many as eight antimicrobials, with S. mitis being the predominant resistant strain showing resistance to all 8 antimicrobials (33%). Strains of S. oralis, S.sanguinis were also found to be multi drug resistant. The results of the MIC determinations with fifteen antimicrobial agents against 260 isolates showed that broad ranges of MICs were obtained with ampicillin, penicillin, cefotaxime, azithromycin, erythromycin, tetracycline, levofloxacin and ofloxacin. However, a narrow range was obtained with vancomycin and linezolid (Table 5). High level of resistance (MIC > or =32 µg/ml) was observed for ampicillin, penicillin G, cefotaxime, erythromycin, tetracycline levofloxacin and ofloxacin (Table 6). In general, isolates of mitis and sanguinius group were most resistant than other strains of VGS.

DISCUSSION

This study shows that among all the patients undergoing tooth extraction, periodontitis was prevalent among a sizeable number of patients (42.5%) and also shows a marked advancement of periodontitis in those patients, whereas the remaining patients (57.5%) were without periodontitis. Periodontal diseases are a second major cause after dental caries for tooth extraction and our findings are in agreement with other similar studies (23, 24). Therefore, the finding that (42.5%) patients undergoing tooth extraction had periodontitis, does not necessarily suggest a meaningful change in the rates of tooth extraction due to periodontitis; however, our study confirmed the trend that periodontal disease was the most frequent reason of tooth extraction in patients over 45 years of age as shown in previous studies (23).

In the present study, we had isolated a total of 260 VGS strains from the subgingival plaque of patients undergoing tooth extraction. Among these isolates, we had isolated few strains that were unusual and uncommon in human clinical samples; namely S. thoraltensis, S. tigurinus and S. pluranimalium and S. hyointestinalis and S. sinensis from the subgingival plaque of these patients. Isolation of these strains from human subgingival plaque has not been reported in literature so far. Our findings are in agreement with Richard Facklam (2002); in his review, he has mentioned that species not yet identified from human sources have been transmitted from nonhuman sources (S. iniae, S. porcinus, and S. suis) to humans has caused documented infections (18); similarly these novel species of VGS isolated in this study may have been transmitted from non-human sources. In the light of these findings and the fact that VGS can cause life threatening systemic infections like infective endocarditis, it is important to identify the individual species accurately. The emergence and increase in the frequency of antibiotic resistance in

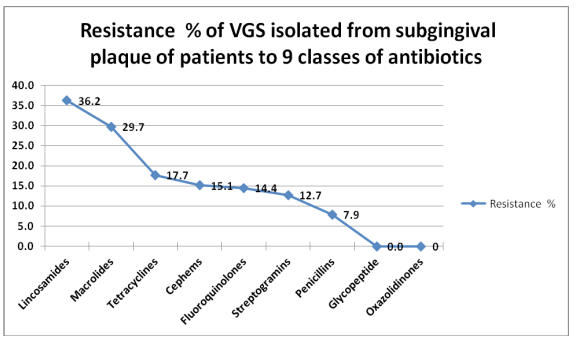

***Figure 1**. Levels of antibiotic resistance shown by VGS (n=260), isolated from subgingival plaque of patients undergoing tooth extraction*

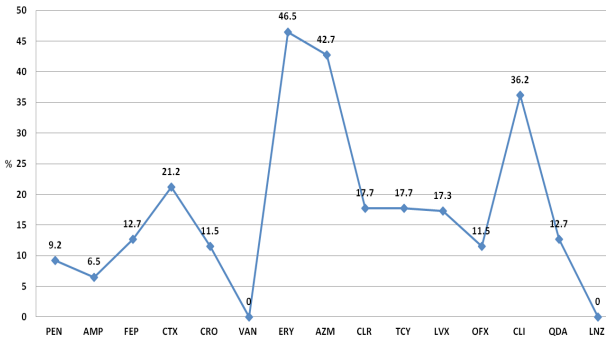

***Figure 2**. Antibiotic resistance rate of VGS (n=260), isolated from subgingival plaque of patients undergoing tooth extraction*

VGS is of considerable concern, as it limits the available options for the therapy of serious infections. We found that the level of resistance to lincosamides and macrolides in viridans group streptococci was higher than previously reported (25, 26). Species-related variability was significant, especially for resistance to penicillins, macrolides, cephems and fluoroquinolones. Heterogeneity in antibiotic susceptibilities among species of viridans group streptococci was evident from the present results. Our results show that isolates of the mitis group were most frequently resistant to lincosamides and macrolides, these findings are in accordance with Teng et al. (27). Macrolides and clindamycin had higher resistance against most isolates in our study. The frequencies of resistance to macrolides and clindamycin were greater than those previously reported (25, 26, 28). Resistance to macrolides was common in most species. Macrolide antibiotics have been suggested as an alternative prophylactic approach to prevent viridans streptococcal bacteraemia or endocarditis for penicillin-allergic patients. However, our results suggest that macrolides are unsuitable as prophylactic agents to prevent viridians streptococci infections. Erythromycin resistance may have evolved in response to differing antibiotic pressure at the community level. The widespread use of erythromycin may contribute to its poor activity against S. pyogenes and S. pneumoniae, as well as some species of viridans streptococci (29, 30).

High resistance to clindamycin was observed (36.2%), and was found in almost all species tested, except the novel isolates of VGS, i.e. S. hyointestinalis, S. sinensis, S. tigurinus and S. thoraltensis. However, we observed high rates of resistance to clindamycin, most frequently in S. oralis (47%), followed by S. mitis (46%) and S. mutans (37%). A high rate of resistance to clindamycin was also observed in Spain (40% of all isolates) and South Africa (41% of S. mitis) (31,32). As reported in other studies, resistance to macrolides alone was less frequent than combined resistance (31). Since the antimicrobial susceptibility patterns of viridans group streptococci differ between species, it is important to identify the individual species accurately. The high frequency of resistance to lincosamides and macrolides among some species of viridans streptococci limits the use of these drugs as therapeutic or prophylactic agents for infections caused by these organisms. Our findings clearly indicate that periodic surveillance of antibiotic susceptibility among various species of viridians streptococci should be carried out by clinical microbiology laboratories worldwide. Such studies are particularly important in areas where macrolide and ß lactam antibiotics are frequently prescribed.

In conclusion, a high frequency of lincosamides and macrolides resistance in oral isolates of VGS and its co-resistance to tetracyclines, cephems, fluoroquinolones, streptogramins and penicillins are reported in this study. Species-related variations in the antimicrobial susceptibilities and emergence of multi-drug resistance pattern in VGS strains are some of the important findings which warrant continuous antimicrobial surveillance of VGS in health and disease.

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