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Identification of Bacteria Isolated from Dental Caries, Abscess, Gingivitis and The Effect of Antibiotics on Them

[1]Dareen El shareef Jadullah [1]Microbiology, Faculty of pharmacy, Qurina International University, Benghazi– Libya,

[1] Email: dareenelshareef@qiu.edu.ly

Abstract— ***Introduction: This study was carried out in three dental clinics in Benghazi to identify and characterize some bacteria in patients with dental caries, abscess and gingivitis and antibiotic resistance patterns to determine the risk to public health. The dental disease specially caries is a significant public health problem affecting a number of children and adult Throughout the globe. Materials and methods: This cross-sectional study was carried out for a period of six months, from October (2020) to April (2021). A total of 100 samples collected from the dental caries patients of various age and sex were processed on different bacterial isolation media like Tryptose Soya Agar, Nutrient Agar, and MacConkey Agar. the colonies were and cultured on Coliform Agar with 5% dehydrated sheep blood, Tadd Hewitt Agar (THA), and Luria-Bertani (LB) medium (10). Results: Four different bacterial species were ascertained from the total hundred samples. bacterial species were isolated (Streptococcus mutans 55%, Pseudomonas aeruginosa 15%, Klebsiella oxytoca 10% and E. coli 20%). Different species of bacteria showed various sensitivity patterns to several kinds of antibiotics. Statistical measurement shows no relationship between bacteria and gender and also the age was statistically not significant (P=0.079, P=0.248), respectively. Conclusion and future scope: In this current study Streptococcus mutants was the major cause of dental caries with major percent of infection, as the same time was found no relationship between (age, gender) and bacterial infection which may be due the lack of culture education and attention to health. Furthermore, studies required health education about antibiotics and selling of all kinds of it as over the counter drug should be stopped by implementing medical rules and regulations***

Keywords- ***Dental, Caries, Gingivitis, Abscess, Antibiotics.***

I. INTRODUCTION

A. Antibiotics and odontogenic infections:

Antibiotics are suggested in the cases of prophylaxis for local and focal infections, besides, for the treatment of odontogenic and no odontogenic infections.[1-2] Antibiotics are not indicated for all odontogenic infections; they should not be used instead of removal of the source of infections [3]. In the case of infection incision and drainage, debridement, and endodontic management followed by systemic antibiotic therapy are recommended [4].

B. Dental disease and bacteria:

Streptococcus mutans (including S. mutans and S. sobrinus sub-species) are often involved in tooth decay. However, dental caries lesions contain a wide range of bacterial species, most of which have not yet been cultured, and yet the bouts of each bacterial species have not yet been determined individually in triggering tooth decay. Other bacteria other than S. mutans, including S. mitis, S. salivarius and S. anginosus, along with Enterococcus faecalis, Actinomyces naeslundii and a number of other lactobacilli causing tooth decay. [5][6]. However, 10% of people with caries do not have significant levels of S. mutans, indicating the presence of other oral species effective in making caries. Likewise, S. mutans is significantly associated with decay lesions and isolates from decay lesions may be more acidic than isolates from healthy teeth Streptococcus mutans is a hetero-fermentative (multi-fermentable) bacterium, which allows it to produce the final product of the acid mixture, and has an advantage for growth in bacterial plaques. This leads to extensive [7][8] acid production following digestion of carbohydrates, and thus reduces the pH of the dental plaque. Sucrose as a vital factor in S. mutans virulence is very important in dental caries and formation of biofilms [9]. Approximately 2.4 billion people (36% of the world's population) have permanent teeth rotting. The disease affects 620 million children or 9% of the world's population [10]. The disease is prevalent in Latin America, the Middle East, and South Asia, with the lowest prevalence in China. In the United States, dental caries is the most common chronic disease in childhood and is five times more common than asthma. In children, the main pathological cause is the loss of teeth. Between 29% and 59% of adults over 5 years of age suffer from dental caries [11].

Antibiotics specifically attacks the cell wall of a number of similar Streptococcus species, including the Streptococcus A group causing sore throats and tooth decay [12] [13]. Antibiotics suppresses the growth of S. mutans in a three-plate

model, which the onset of suppression of these species begins very quickly. Caryophyllus aromaticus is a scientific name for the cluster tree, which is native to the Molok Islands and eastern Indonesia, and is found in Tanzania, Madagascar, Brazil, and temperate and tropical regions. Due to its particular beauty, it is grown today as the ornament in the most part of the world.

C. Antibiotic used in Dentistry:

C.1. Beta-Lactams: Amoxicillin:

Amoxicillin is a penicillin antibiotic that acts against Gram-negative bacilli [14] [15], Some practitioners also prefer to administer the combination of amoxicillin and metronidazole or amoxicillin/clavulanate to treat odontogenic infection [16] [17]. The therapeutic dosage for amoxicillin is 500 mg every 8 hours or 1000 mg every 12 hours [18].

Amoxicillin with Clavulanic Acid (Co-Amoxicla Amoxicillin with clavulanic acid (co-Amoxiclav) is a broad- spectrum antibiotic that is believed to be the second most prescribed antibiotic by dentists [19]. The administration of co-Amoxiclav or metronidazole is suggested [20]. A high dose of co-Amoxiclav ((875/125) mg every 8 hours or (2000/125 mg) every 12 hours) is a proper choice in the cases of severe odontogenic infections, such as abscess and pulpitis [21].

Cephalosporin: Cephalosporins are classified in beta lactam antibiotics and can inhibit the biosynthesis of bacterial cell walls [22]. Cephalosporins can act against aerobic bacteria, and their combination with metronidazole could cover both aerobic and anaerobic bacteria [23]. Cephalexin and cefazolin are among the most commonly prescribed first-generation cephalosporins and third generation Ceftriaxone in dental practice [24]. Cephalexin could be prescribed for penicillin-allergic patients, with the dosage of 2 g orally 1 h before dental procedures. Cefazolin and Ceftriaxone are suggested for patients who are allergic to penicillin and cannot take the medication by mouth, with the dosage of 1 g IV or IM 30 minutes before the procedure [25].

Nitroimidazoles (metronidazole) Metronidazole has bactericidal activity and acts against anaerobic microorganisms by inhibiting the nucleic acid synthesis; the agent also showed antiprotozoal activity and does not disrupt the protective aerobic microbiota [26][27]. Combined administration of amoxicillin and metronidazole, this drug is commonly prescribed with a dosage of 500–750 mg every 8 hours [18].

D. Macrolides:

Azithromycin: Azithromycin is a bacteriostatic has a great potency against Gram-negative pathogens and is considered to be the safest among the macrolides [28][29]. It isn't suggested as the first-line treatment of odontogenic infections and is usually prescribed as an alternative in penicillin-allergic patients [30]. The dosage of the drug is 500 mg once a day for three days, in case of therapeutic prescription, and 500 mg 1 hour before the oral procedure.

Clarithromycin: Clarithromycin is a bacterial protein synthesis inhibitory and matrix metalloproteinase (MMP) regulating activities that could fight against intracellular pathogens by penetrating the cells [31]. The prescription of clarithromycin can be a logical approach for suppressing the pulp and periodontal infections [32] [33].

Lincosamides (clindamycin) Clindamycin is a broad-spectrum bacteriostatic antibiotic that covers both aerobic and anaerobic pathogens. This drug is the newer generation of lincomycin, and it has suitable potency against bone, joint, and odontogenic infections [34] [35].

Fluoroquinolones (ciprofloxacin):

Ciprofloxacin is among the second generation of fluoroquinolone antibiotics and is active against Gram-positive and Gram-negative pathogens [36][37]. This is antibiotic showed excellent antibacterial potency, whilst having minimum side effects [28][38][39]. This drug is usually administered orally with a dosage of 500 mg every 12 hours to treat odontogenic infections [25].

Tetracycline: Tetracycline is a bacteriostatic antibiotic that is active against Gram-positive and Gram-negative bacteria, acting by blocking the synthesis of protein through binding to the ribosomal subunit [40]. The drug could be a reasonable prescription for the treatment of periodontal diseases, as it has anti-inflammatory activity. Tetracycline is recommended in cases of periodontal diseases, improving marginal attachment and enhancing bone graft [28][41] .

II. METHODS AND MATERIALS

A. Study design:

This was experimental study it was done inpatients referred to three dental clinics in Benghazi (Central Dental Clinic, Benghazi University Clinic (Al-Humaydah) and Al-Jalaa Hospital for surgery & accidents). This cross-sectional study was carried out for a period of six months, from October (2020) to April (2021).

B. Sample collections:

A total of 100 samples were randomly selected to isolate common oral bacteria and evaluate the antibiotic susceptibility to it. To isolate common oral bacteria, 5 ml of sterile phosphate saline buffer was first placed in each of the sterile test tubes and then, using sterilized swabs from the buccal surface and the location of the caries of the target teeth, abscess and gingivitis, the samples were taken. Samples were

stored in a portable refrigerator (~4°C) and transferred to the laboratory. Samples were stored at 80°C until further examination.

C. . Isolation of common bacteria:

To isolate the bacteria, samples were vortexed for 30 seconds before the bacteria were isolated from the swab and inserted into the phosphate saline buffer solution. Then 100 µL of the suspension was removed and diluted in saline buffer. Then, 20 µL of each diluted suspension was put on a heart and brain infusion (BHI) culture medium. The plates were then incubated at 37°C for 72 hours. Plates were then placed in aerobic and anaerobic conditions (in anaerobic jar). After 72 hours, the colonies were isolated and cultured on Coliform Agar with 5% dehydrated sheep blood.

D. Statistical analysis:

The descriptive data collected in this study were represented by using IBM SPSS software version 28 was analyzed and reported as tables and charts and data was expressed as frequencies and percentages. Chi square test was employed to determine the difference between bacteria and each variable in the study.

E. Materials:

The materials used are antibiotic disks. Antibiotic treatment varied from patient to patient. The antibiotics were used during the study period for all specimens, and they are AMC-Augmentin (20/10 µg), CRO-Ceftriaxone (30 µg), GN-Gentamycin (10 µg), AX- Amoxicillin (10 µg), VA-Vancomycin (30 µg), P-Penicillin (10 µg), TE-Tetracycline (30 µg) and CIP-Ciprofloxacin (5 µg), were the antibiotics that demonstrated in-vitro activity regularly against all culture organisms.

F. Ethical clearance:

Approval for the study was obtained from the Qurina international university, dental clinics in Benghazi (Central Dental Clinic, Benghazi University Clinic (Al-Humaydah) and Al-Jalaa Hospital for surgery & accidents) and consent was obtained from patients before sampling process.

III. RESULTS AND DISCUSSION

In figure (I) and table (I), most of the samples in this study were from males representing 52% while female lead second with 48%.

TABLE I. *Distribution of sample members by "Gender:*

Gender	Frequency	Percent
Female	48	48.0%
Male	52	52.0%
Total	100	100.0%

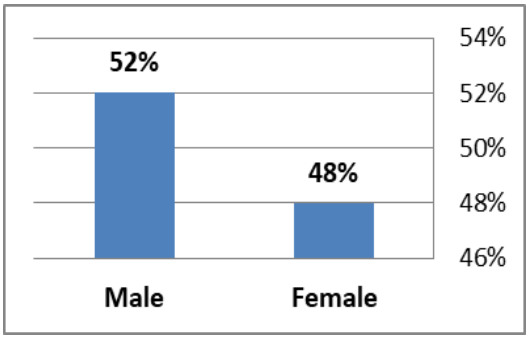

Figure I: *Gender percent curve*

The distribution of sample members by "Age":

In addition, most of the samples were among individuals in the age group of Less than 20 years old with 34%, second age group between 20 to 30 with 27%, while 30 to 40 age group lying third with 20% and last age group more than 40 years old with 19% as shown in figure (II) and table (II).

TABLE II: *Distribution of sample members by "Age":*

Age	Frequency	Percent
Less than 20	**34**	**34.0%**
20 less than 30	**27**	**27.0%**
30 to 40	**20**	**20.0%**
More than 40	**19**	**19.0%**

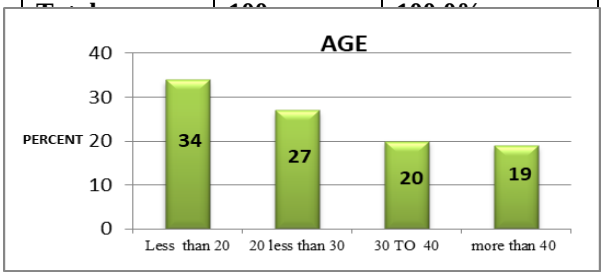

Figure II: Age percent curve

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The distribution of sample members by "Case ":

Table (III) and figure (III) show distribution of dental diseases percent between patients as dental caries take the lead with 65%, gingivitis with 20% and abscess with 15%.

TABLE III. *Distribution of sample members by "Case ":*

Disease	Frequency	Percent
Abscess	15	15.0%
Caries	65	65.0%
Gingivitis	20	20.0%
Total	100	100%

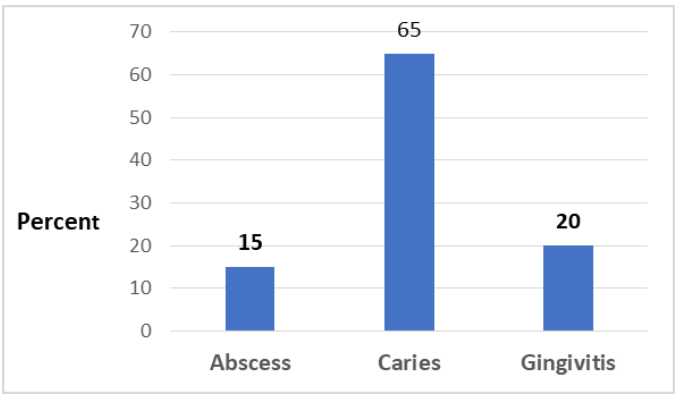

FIGURE III: *Cases percent curve*

The distribution of different bacterial species on swap samples:

The results acquired from the microorganisms amalgamated with dental plaques, caries and abscess shows variation in bacterial percent as 15% was for *Pseudomonas aeruginosa*, 55% for *Streptococcus mutans*, 10% for *Klebsiella oxytoca* and 20% for *E. coli* as seen in table (IV) and figure (IV).

Table (IV)*: Distribution of different bacterial species on swap samples*

Species	Frequency	Percentages
Pseudomonas aeruginosa	**15**	**15**%
Streptococcus mutans	**55**	**55**%
Klebsiella oxytoca	**10**	**10**%
E.coli	**20**	**20**%
Total	**100**	100%

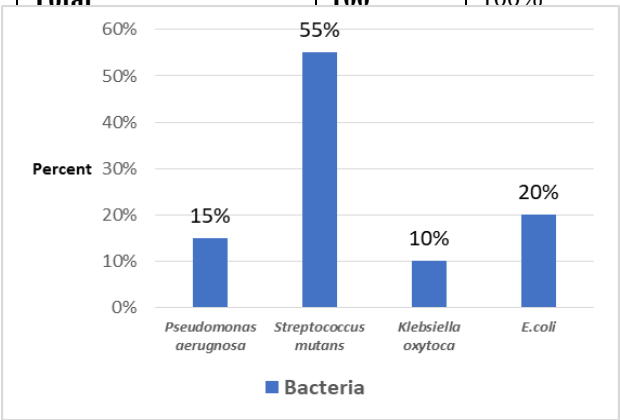

FIGURE (IV): *Bacteria percent curve*

The Antibiogram of Pseudomonas aeruginosa:

Different species of bacteria showed various sensitivity patterns to some of antibiotics. As seen in the following table every individual bacterial species demonstrated zone of inhibition to couple of them, was measured as sensitive and resistant. Table (V) shows isolates of *Pseudomonas aeruginosa* found resistant to Ciprofloxacin, Gentamicin and vancomycin, while slightly sensitive to Rocephin (20%) and highly sensitive to Tetracycline, Amoxicillin with (100%)and Augmentin (80%) in the other hand moderately sensitive to penicillin (65%).

Table (V): *Antibiogram of Pseudomonas aeruginosa:*

Type Of Bacteria	Antibiotics	Sensitive	Percent Of sensitivity	Resistance
Pseudomonas aeruginosa	Augmentin	+++	80%	-
	Rocephin	+	20%	-
	Ciprofloxacin	-	-	R
	Gentamicin	-	-	R
	Penicillin	++	65%	-
	Tetracycline	++++	100%	-
	Amoxicillin	++++	100%	-
	Vancomycin	-	-	R

The antibiogram of Klebsiella oxytoca:

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As shown in table (VI) the isolates of *Klebsiella oxytoca* was highly sensitive to Penicillin, Amoxicillin with (100%) and Augmentin (80%), while slightly sensitive to Vancomycin solely resistance to Ciprofloxacin and Gentamicin.

TABLE (VI): *Antibiogram of Klebsiella oxytoca*

Type of Bacteria	Antibiotics	Sensitive	Percent Of sensitivity	Resistance
Klebsiella Oxytoca	Augmentin	+++	80%	-
	Rocephin	++	20%	-
	Ciprofloxacin	-	-	R
	Gentamicin	-	-	R
	Penicillin	++++	100%	-
	Tetracycline	-	-	R
	Amoxicillin	++++	100%	-
	Vancomycin	+	20%	-

In the following table (VII), multiple antibiotic sensitivity for *Streptococcus mutans* isolates in compared to the last ones, as found sensitive to Augmentin, vancomycin (60% & 70%) respectively, moderately sensitive Rocephin and tetracycline with (50%) and slightly sensitive for Ciprofloxacin (30%) and penicillin (15%). The highest percent of sensitivity found in amoxicillin with (90%) while resistance behavior to gentamicin.

The antibiogram of E. coli:

As shown in table (VIII) *Escherichia coli* species isolated from the patients exhibited resistance to some broad spectrum antibiotics such as Ciprofloxacin and Gentamicin, while highly sensitive to Penicillin, Amoxicillin, Vancomycin with (90%) Tetracycline (80%) and Augmentin (70%) while slightly sensitive to Rocephin (30%).

TABLE (VII): *Antibiogram of E. coli:*

Type of Bacteria	Antibiotics	Sensitive	Percent Of sensitivity	Resistance
E.coli	Augmentin	+++	70%	-
	Rocephin	++	30%	-
	Ciprofloxacin	-	-	R
	Gentamicin	-	-	R
	Penicillin	+++	90%	-
	Tetracycline	+++	80%	-
	Amoxicillin	+++	90%	-
	Vancomycin	+++	90%	-

TABLE (VII): *Antibiogram of Streptococcus mutants*

Type of Bacteria	Antibiotics	Sensitive	Percent Of sensitivity	Resistance
Streptococcus mutants	Augmentin	+++	70%	-
	Rocephin	++	50%	-
	Ciprofloxacin	+	20%	-
	Gentamicin	-	-	R
	Penicillin	+	15%	-
	Tetracycline	++	50%	-
	Amoxicillin	+++	90%	-
	Vancomycin	++	60%	-

The relationship between bacteria and the gender:

Chi-square test is used to explore the relationship Bacteria and the variables in the Cross tabulation, the chi-square test gives a probability value (*P.* value), if it is less than the level of significance (0.05), the decision is made that there is a statistically significant relationship between the two variables, otherwise there is no significant relationship. From the table (IX) && figure (V), we find that the (p. value) of the chi-square test was (0.079), which is greater than significance level (0.05), this means that there is no relationship between bacteria and gender.

TABLE (IX): *Cross tabulation using chi-square test to correlate between Bacteria and gender*

		Gender		Total	*P.* value
		Female	Male		
Bacteria	***Klebsiella oxytoca***	4	6	10	0.079
	Pseudomonas aeruginosa	7	8	15	
	Streptococcus mutans	32	23	55	
	E.coli	5	15	20	
Total		48	52	100	

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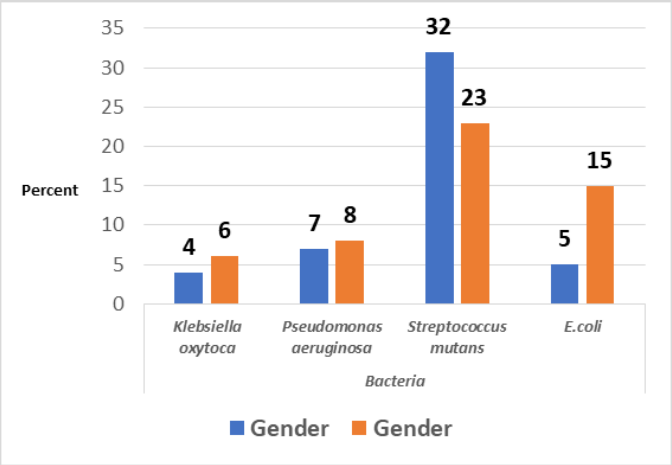


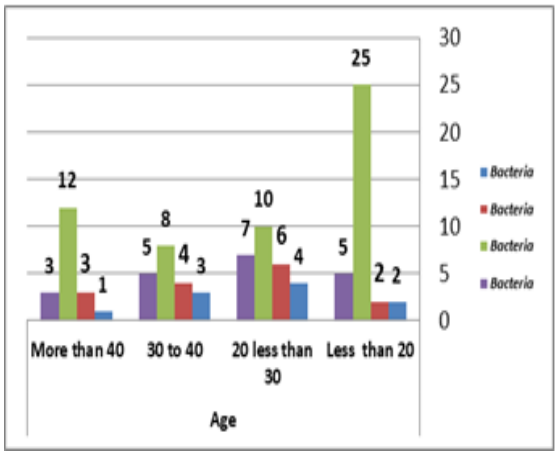
FIGURE (V): *The relationship between bacteria and gender chart*

The relationship between bacteria and the age:

From the table (10), and figure (6) we find that the (*p*. value) was (0.248), which is greater than significance level (0.05), this means that there is no relationship between bacteria and age.

TABLE (X): Cross tabulation using chi-square test to correlate between bacteria and age:

		Age				Total	*p*. value
		Less than 20	20 less than 30	30 to 40	More than 40		
Bacteria	***Klebsiella oxytoca***	2	4	3	1	10	(0.248)
	Pseudomonas aeruginosa	2	6	4	3	15	
	Streptococcus mutans	25	10	8	12	55	
	E.coli	5	7	5	3	20	
Total		34	27	20	19	100	



The relationship between bacteria and the cases .

From the table (XI), and figure (VII) we find that the (*p*. value) of the chi-square test was (0.000), which is less than (0.05), this means that there is relationship between Bacteria and Cases (statistically significant).

FIGURE (VI): *The relationship between bacteria and age chart*

TABLE (XI): *Cross tabulation using chi-square test to correlate between Bacteria and Case*

		Case			Total	*p.* value
		Abscess	Caries	Gingivitis		
Bacteria	***Klebsiella oxytoca***	0	10	0	10%	0.000
	Pseudomonas aeruginosa	15	0	0	15%	
	Streptococcus mutans	0	55	0	55%	
	E.coli	0	0	20	20%	
Total		15	65	20	100	

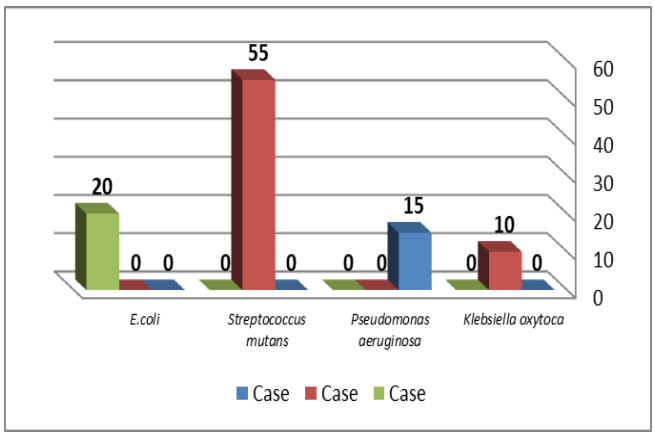


FIGURE (IV): *The relationship between bacteria and cases char*

IV. DISCUSSION

World health organization has declared that decreased oral health impact overall health of an individual and dental caries is an important contributor for poor oral health throughout the world [42] [43] [44]. The result of this study shows 90% infection with various type of bacteria and 10% infection from lab (*Klebsiella oxytoca*). *S. mutans* as major cause of infection in this study with 55% is considered as an important organisms involved in dental caries, where Amoxicillin, Augmentin and rocephin was good choice as therapeutic agents for the management of dental caries. In this study, as this result was similar to Orhue O Philip set *et al.*[43],where *Streptococcus mutans* was the main etiologic agent of dental caries and in contrary different in management as Clindamycin seems to be the best therapeutic agent for the management of dental caries and could be applied for blind treatment, while Ciprofloxacin, not effective against etiologic agents isolated in this study, similar to ours study as known to be weak choice for dental caries treatment, and may not be useful for the treatment of dental caries. In study by Maryam Abdul Khuder *et al.* was opposite to us as most of the bacterial isolates of *Streptococcus mutans*, *K. pneumoniae*, *S. aureus*, and *E. coli* were susceptible to ciprofloxacin [44] An antibiotic susceptibility test was done for the bacteria isolates Some antibiotics were used to show the effect on different types of bacteria isolated from dental caries patients. It has been found that there is variation in resistance, and most isolates show resistance to two of these antibiotics. In the current study, the susceptibility of Ciprofloxacin and Gentamicin bacterial isolates was tested and was resistance in most bacteria except in *Streptococcus mutants* was weak sensitive to Ciprofloxacin with 20%. These results were opposite with results achieved by Domalaon *et al.*, [47] who found that the majority of Gram-positive and gram negative were susceptible to

Ciprofloxacin and gentamicin. As present in our study *Streptococcus mutans* and *E. coli* was sensitive to penicillin, amoxicillin, tetracycline and vancomycin, similar to study by Maryam Abdul Khuder, Mohammed Jassam *et al.* [44] While in study by Orhue O Philips *Streptococcus mutans* strains the findings that all isolates were resistant to Gentamycin as this study, while in contrast to our study because, *Streptococcus mutans* was sensitive to Tetracycline [44]. Also in this study, the European Committee on Antimicrobial Susceptibility Testing [48] has reported increasing resistance to penicillin among oral streptococci incompatible with our study as was weak sensitive to penicillin.

V. CONCLUSION

In this current study *Streptococcus mutants* was the major cause of dental caries with major percent in this study, while other percent was for *Pseudomonas aeruginosa* for abscess, and *E. coli* for gingivitis. Most of the bacterial infection was resistant to gentamicin and ciprofloxacin except *Streptococcus mutants* was weak sensitive to ciprofloxacin, it could be due to use of antibiotics without proper recommendation. In this study there is no relationship between age and bacterial infection which may be due the lack of culture education at an earlier age, lack of or attention to health. Furthermore, studies required about antibiotics use to find out ways to manage dental caries and infection effectively. Also should applied health education to communities about antibiotic and selling of all kinds of it as over the counter drug, by implementing medical rules and regulations.

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