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International Journal of Current Research
Vol. 10, Issue, 06, pp.70937-70941, June, 2018

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

APPLICATION OF ANTIBIOTICS IN ENDODONTICS

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ARTICLE INFO

Article History:
Received 29th March, 2018
Received in revised form
23rd April, 2018
Accepted 24th May, 2018
Published online 30th June, 2018

Key Words:
Endodontic Infections,
TAP, MTAD, Antibiotic Prophylaxis.

ABSTRACT

The benefits of correct use of antibiotics include the resolution of infection and prevention of the spread of disease. During endodontic treatment, antibiotics may be given systemically or regionally to achieve aseptic environment and to prevent the pathogenesis and progression of pulp and periapical diseases. This paper is to discuss the use antibiotic in the field of Endodontics.

Citation: Dr. Steffin Elsa Money, Dr. Swetha, H.B. and Geeta, I.B. 2018. "Application of antibiotics in endodontics", *International Journal of Current Research*, 10, (06), 70937-70941.

INTRODUCTION

Antibiotics are substances produced by microorganisms, which suppress the growth of or destroy other microorganisms. The production of penicillin for clinical use in 1941 marked the beginning of the golden era of antibiotics. Many infectious diseases which were earlier incurable can now be treated with just few doses of antimicrobial drugs (Textbook of pharmacology, 2016). The key to successful management of infection of endodontic origin is adequate debridement of the infected root canal and drainage for both soft and hard tissue (AAE Guidance on the Use of Systemic Antibiotics in Endodontics, 2017). During Endodontic procedure antibiotics can be given either systemically or locally. Systemic Antibiotics should be prescribed or used for dental infections on the basis of defined indications (Miles, 1984). The local application of antibiotics is an effective mode of disinfection in endodontics because systemic antibiotics fail to reach the necrotic pulp (Gilad *et al*., 1999).

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DOI: https://doi.org/10.24941/ijcr.31201.06.2018

Ultimately, Endodontists must weigh the benefits and risks of antibiotics, and make an informed decision on the appropriateness of using antibiotics (AAE Guidance on the Use of Systemic Antibiotics in Endodontics, 2017).

SYSTEMIC ANTIBIOTICS: Systemic indication of antibiotics is when there is a spread of infection such as fever, cellulitis, lymphadenopathy, swelling and it should only be used as adjuvant therapies in cases with evidence of systemic involvement following adequate endodontic disinfection and abscess drainage if swelling is present (Antibiotics In Endodontics, 2017; AAE Guidance on the Use of Systemic Antibiotics in Endodontics, 2017). In addition, patients who are immunocompromised or have predisposing conditions such as previous endocarditis should be medicated as a prophylactic measure (2).

ANTIBIOTIC PROPHYLAXIS

Conditions requiring antibiotic prophylaxis

- Previous history of endocarditis.
- Total joint replacement.
- Mitral valve prolapse
- Valvular regurgitation

- Complex and cyanotic congenital heart diseases.
- Surgically constructed pulmonary shunts.
- Rheumatic heart diseases
- Prosthetic valve replacement.
- Uncontrolled diabetes mellitus

LOCAL ANTIBIOTIC: Bacteria located inside dentinal tubules are protected from host defense cells, systemic antibiotics and chemo mechanical preparation. Therefore, endodontic medicaments must be able to penetrate into dentinal tubules and kill bacteria within them (Mohammadi, 2009). Advantages of locally used antibiotic agents include efficient and predictable disinfection and reducing systemic complications of antibiotic medication. It also helps in introducing a high drug concentration at the local site. Disadvantages of local drug delivery includes possible development of bacterial resistant strains (antimicrobial resistance), allergic reactions, inhibition of angiogenesis and tooth staining or discoloration.

Grossmann poly antibiotic paste: This was the first reported local use of an antibiotic in endodontic treatment in 1951. When Grossman used a polyantibiotic paste known as PBSC (penicillin,bacitracin, streptomycin, and caprylate sodium) (Grossman, 1951). All the compounds were suspended in a silicone vehicle. Later in 1975 Food and Drug Administration banned PBSC for endodontic use, because of the risk of sensitization and allergic reactions (Abdenour *et al*., 2004).

Ledermix Paste: Ledermix is used both as pulp capping agent and as an intracanal medicament. Ledermix paste is a combination of 3.2% demeclocyoclineHcl and a steroid 1% tramcinoloneacetomide in polyethylene glycol base. Steroids mainly reduce the inflammation and pain, while the antibiotics limit the infection (Athanassiadis *et al*., 2007). It plays a significant role in treatment of traumatically injured teeth. Teeth treated with ledermix paste showed favorable healing and less root resorption. The steroid and tetracycline lower the inflammatory response along with intribition of clastic cell mediated resorption and promoting periodontal healing in replanted teeth. Advantage of ledermix paste is, it is water soluble, well rinsed out easily and does not cause systemic side effect in intradental use (Abbott, 1992)

Septomixine forte: Septomixine Forte paste contains dexamethasone, halethazole tartrate, neomycin sulfate, polymyxin B sulfate, and tyrothricin. Septomixine Forte paste, however, is no longer recommended because the antibiotics (neomycin and polymyxin B sulfate) are unsuitable for use against endodontic bacteria due to their inappropriate spectra of activity (Athanassiadis, 2007)

Triple antibiotic paste: Since root canal infections are poly microbial in nature and because of the complexity of infections, a combination of antibiotics are needed to address the diverse microbial flora. Metronidazole, minocycline and ciprofloxacin are mixed in a ratio of 3:3:1.Metronidazole is selectively toxic and effective against anaerobic organisms. Minocycline primarily bacteriostatic, Ciprofloxain is a synthetic Fluoroquinolone with rapid bactericidal action. Used in revitalization and regeneration procedures in case of avulsion, in large periradicular lesions, in primary teeth and root fracture.

Disadvantages includes bacterial resistance and also the Use of minocycline can cause tooth discoloration (Antibiotics In Endodontics - A Concise Review, 2017)

Double antibiotic paste: This paste has also been successfully used in root canal treatment. Similar to triple antibiotic paste but excludes minocyclines. This will decrease the tooth discoloration which was a disadvantage in triple antibiotic paste.

MTAD: It is a mixture of 3% doxycycline, citric acid and a detergent polysorbate 80. MTAD is capable of removing the smear layer without affecting or altering the structure of a dentinal tubules and disinfecting the root canal system (Antibiotics In Endodontics - A Concise Review, 2017). MTAD is commercially available as powder-Liquid system. The liquid contains 4.25% citric acid and 0.5% polysorbate 80 (Tween 80). The powder contains 3% doxycycline hyclate and is a broad spectrum antibiotic (Bogardus, 1979). MTAD has best antibacterial efficiency against E faecalis when compared to 2.5% Sodium Hypochlorite and 2% Chlorhexidine (Davis, 2007)

Tetraclean: Tetraclean is another combination product similar to MTAD but differs from MTAD by the concentration of doxycycline (50mg/ml) and the type of detergent polypropylene glycol. The use of tetraclean was able to reduce 90% bacteria load after 5 minutes and 99.9% after 30 minutes of application.Teraclean is more effective than MTAD against the endodonitic pathogen E.Faecalis in the planktonic culture and mixed species in in vitro biofilm (Pappen *et al*., 2010)

Medicated gutta percha: Medicated guttapercha contains 10% Iodoform and 10% tetracycline impregnated guttapercha (TGP). It helps to reduce the growth of bacteria inside the obturated root canal. TGP also prevents the colonization of bacteria on the guttapercha points and within the root canals (Emre *et al*., 2008)

Odontopaste: Odontopaste is a Zinc oxide-based endodontic dressing and is the most effective against Enterococcus faecalis. Composed of clindamycin hydrochloride, triamcinolone acetonide and calcium hydroxide. It is bacteriostatic and prevents bacterial repopulation in the root canal system (Antibiotics In Endodontics - A Concise Review, 2017).

Antibiotic-containing scaffolds: Bottino *et al*. has suggested that the polymer-based antibiotic-containing electrospun scaffolds may act as a biologically safe antimicrobial drug delivery system for regenerative endodontics. This can improve drug delivery due to high surface area fibers arranged in an interconnecting structure that allows controlled drug release and improve drug adaptation to the canal wall in the regeneration procedure. As the scaffold degrades over time, it does not require to be removed, thus, reduces appointments and a subsequent risk of bacterial contamination. In addition, the drug release can be manipulated in a mode-rapid, intermediate or delayed, depending on the polymer used.

Antibiotic alternatives from nature: Natural and herbal products have been used in medicine and dentistry since time unknown. Use of plant products in medicine is known as phytomedicine or phytotherapy.

Table 1. Endodontic infections requiring systemic antibiotics

Pulp/Periapical Condition	Radiographic and Clinical Symptoms
Acute apical abscess in medically compromised patients	• Patients with systemic diseases causing impaired immunological function • Localised fluctuant swellings
Acute apical abscess with systemic involvement	• Trismus • Lymphadenopathy • Malaise • Rise in body temperature
Progressive infections	• Cellulitis or spreading infection • Osteomyletis • Rapid onset of severe infections
Persistant infections	Chronic exudation, which is not resolved by regular intracanal procedures.

Table 2. Endodontic infections not requiring systemic antibiotics

PULP/PERIAPICAL CONITION	RADIOGRAPHIC AND CLINICAL SYMPTOMS
Symptomatic irreversible pulpitis	Pain/tenderness on percussion
Pulp necrosis	• tenderness on percussion • PDL widening • Non-vital tooth
Acute apical periodontitis	• Pain • Tenderness on percussion/ biting • Widening of periodontal space
Chronic apical abscess	• Sinus canal opening present • Periapical radiolucency
Acute apical abscess with no systemic involvement	Localised fluctuant swellings

Table 3.For traumatic injuries

TYPE OF TRAUMA	NEED FOR SYSTEMIC ANTIBIOTICS
Tooth fracture	NO
Concussion, subluxation	NO
Extrusion	NO
luxation injuries of permanent dentition	NO
Reimplantation of avulsed tooth	YES

Table 4. Commonly prescribed antibiotics with dosage

NAME	MECHANISM OF ACTION	EFFECTIVNESS	DOSAGE
Penicillin VK	Inhibits cell wall synthesis	Against facultative and anaerobic microorganisms	A loading dose of 1,000 mg of penicillin VK should be orally administered, followed by 500 mg every four to six hours for five to seven days.
Amoxicillin	Inhibition of biosynthesis of cell wall mucopeptide during bacterial multiplication	against gram positive than gram negative	The usual oral dosage for amoxicillin is 1,000 mg loading dose followed by 500 mg every eight hours for five to seven days
Augmentin- The combination of amoxicillin with clavulanate	Clavulanate is a competitive inhibitor of the betalactamase enzyme produced by bacteria to inactivate penicillin + cell wall synthesis inhibition by amoxicillin	gram positive and gram negative	1,000 mg loading dose followed by 500 mg every eight hours for five to seven days
Doxycycline – tetracyclines	bacteriostatic, inhibiting protein synthesis by binding to 30S ribosomes	gram positive and gram negative microorganisms	100 mg (bid)
Ciprofloxacin	Inhibits the enzyme bacterial DNA gyrase- bactericida	potent activity against gram negative bacteria but very limited activity against gram positive bacteria, not effective against anaerobe	500 mg at every 12 hr
Clindamycin-	Protein synthesis inhibition in bacteria by binding to 50 s ribosome	gram-positive facultative microorganisms and anaerobes also against certain gram negative organisms	gram-positive facultative microorganisms and anaerobes also against certain gram negative organisms
Metronidazole	Redox reaction release free radicals	Effective against anaerobes	250 – 500 mg (qid)

Table 5. Procedures requiring antibiotic prophylaxis

Dental procedures at high risk	Low risks
• Dental extractions • Periodontal procedures – surgeries, SRP • Dental implants placement, Reimplantation of avulsed tooth • Endodontic instrumentation beyond apex • Endodontic surgery, Placement of retraction cord • Placement of orthodontic bands • Intraligamentary and intraosseous injections	• Restorative procedures • Intracanal endodontic treatment and post placement and core • Placement of rubber dam, removable partial dentures • Orthodontic appliance adjustments • Taking oral impressions, oral radiographs, fluoride gels application

Situation	Agent	Regimen—Single Dose 30-60 minutes before procedure	
		Adults	Children
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin **OR**	2 g IM or IV*	50 mg/kg IM or IV
	Cefazolin or ceftriaxone	1 g IM or IV	50 mg/kg IM or IV
Allergic to penicillins or ampicillin—Oral regimen	Cephalexin**†	2 g	50 mg/kg
	OR		
	Clindamycin	600 mg	20 mg/kg
	OR		
	Azithromycin or clarithromycin	500 mg	15 mg/kg
Allergic to penicillins or ampicillin and unable to take oral medication	Cefazolin or ceftriaxone†	1 g IM or IV	50 mg/kg IM or IV
	OR Clindamycin	600 mg IM or IV	20 mg/kg IM or IV

Since chemical and synthetic products are expensive and cause cytotoxic reactions and are not very efficient in elimination of bacteria, herbal products are used (Sharad Kamat, 2016).

Curcumin: Curcumin which is the main yellow bioactive component of turmeric has been shown to have a wide spectrum of biological actions, including antimicrobial, anti-inflammatory and anti- oxidant activities. A study showed that curcumin was able to demonstrate complete eradication of E. faecalis (Neelakantan, 2013).

Propolis: Propolis is prepared from resin collected by bees from trees of poplars, conifers and flowers of genera clusia. The pharmacologically active constituents in propolis are flavonoids, phenolics and aromatics. Propolis is a good antimicrobial and anti-inflammatory agent, which can serve as a better intracanalirrigant and intracanal medicament (Madhu Pujar, 2011).

Green tea: The poly phenols found in green tea have antimicrobial, antioxidant, anti cariogenic, anti inflammatoryproperties. Green tea has antibacterial property against E faecalis planktonic cells (PallaviYaduka, ?)

Lemon solution: Lemon solution is a rich source of citric acid. Fresh lemon solution can be used as an intracanal medicament. It is effective against E. Faecalis (Sharad Kamat, 2016)

Conclusion

The primary aim of endodontic treatment is to remove as many bacteria as possible from the root canal system and then to establish an environment in which remaining organisms cannot survive.

The use of systemic antibiotics in endodontics should be limited to specific cases so as to avoid their over prescription which can lead to resistance.

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