Selected aspects of treatment of irreversible pulpitis

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ABSTRACT

On the basis of the available literature on the subject, the causes and possible treatment options of irreversible pulpitis are discussed. The justifiability of the available treatment methods is also verified. The advantages and disadvantages of the available pulpitis treatment methods are discussed. The issue of toxicity of materials used in mortal endodontic treatment is highlighted. The causal relationship between endodontic treatment and focal diseases is explored.

Keywords: Caries, irreversible pulpitis, devitalization

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CARIES – THE MAIN CAUSE OF PULPITIS

Dental caries – a historical perspective

Dental caries have a very long history and have accompanied humans since the dawn of time. It is not a disease affecting humans exclusively. Dental caries were also identified in Paleozoic fish or herbivore dinosaurs from the Mesozoic. They were also found in contemporary wildlife, including bears.

The oldest proof of dental caries in humans was found in the skull of *Homo rhodesiensis* (estimated to be 650,000 – 160,000 years old), where extensive caries and damaged dental crown were observed. Five teeth with signs of caries were preserved. Neanderthals (who lived 4,000 – 15,000 years BC) suffered from enamel hypoplasia and periodontal diseases, but were relatively rarely affected by dental caries. Among the analyzed 1,250 Neanderthal teeth, only 6 had signs of caries [1]. Subsequent archeological surveys found proof of dental caries in the skull of a Neanderthal from Chapelle-aux-Saints, aged 40,000 years old, and a Neanderthal from Gibraltar (i.e. the Rhodesian skull) [2]. The presence of dental caries was also found in the famous Neolithic ice mummy named Ötzi from 3,300 BC, found in 1994 in Austrian Alps [3].

Diet plays a significant role in the development of dental caries. Lifestyle changes trigger changes in dietary patterns and impact dental caries. The discovery of fire initiated the first changes in the dietary patterns of humans. However, the human diet was revolutionized by the domestication of animals and the beginning of farming, mainly of hops rich in carbohydrates. Thus, humans became partially independent from the forces of nature. Those changes enabled humans to provide constant access to food, regardless of seasonal migration of animals or natural vegetation. The consequence of those changes was constant access to products rich in carbohydrates and thus an increase of dental caries incidence [1].

Dental care in ancient Egypt

Today, dental care is associated with a number of advanced techniques of caries treatment, as well as state-of-the-art, expensive equipment which guarantees more precise performance of dental procedures. From this perspective, it is hard to believe that Ancient Egyptians were able to treat caries or remove teeth. The Egyptians cared for their teeth with the use of herbal washes [4].

The consumption of mixed hops with ubiquitous sand caused pathological abrasion of the teeth in Egyptians. The progressing erosion uncovered the dental pulp, caused inflammation and the formation of periapical abscesses. During archeological digs, recipes for tooth care products were found, composed of rock salt, red ochre, and honey. The recipes instructed the user to mix the ingredients well and make a concoction to wash the mouth. There were also other recipes for medications for treating gingivitis or tooth erosion, or mitigating tooth ache. Some of those recipes are in use until this day [5-10].

The complication of untreated dental caries is pulpitis. Pulpitis may be either reversible or irreversible. The greatest diagnostic challenge is to determine the type of irreversible pulpitis. Irreversible pulpitis is related to lesions such as pulp necrosis, abscess lesions, and gangrene, which may cause inflamed periodontal tissue, abscesses, cysts, or even sepsis.

The first attempts at treatment, consisting of dental pulp removal, date back to the beginning of the 19th Century. Initially, this was performed by cauterizing the dental pulp with either heated-up tools or chemicals. It was only after 1836 that the Spooner brothers introduced arsenic as a medication. From that moment, extirpation became a widely used method for treating pulpitis.

Arsenic is a strong protoplasmic poison that inhibits the biological processes and division of cells. It paralyzes vessels causing nourishment disorders and consequently liquefactive necrosis. The process is rapid and arsenic frequently penetrates through the apical foramen and causes bone necrosis. Arsenic preparations are used only in patients with allergy to paraformaldehyde, if the intravital pulp treatment method cannot be applied [11]. The Committee for Medicinal Products for Human Use (CHMP) has flagged the use of arsenic for tooth devitalization as inadvisable [12].

Summary of CHMP's position

Having considered all the available data from pre-clinical studies, clinical trials, published reports, and information gathered after the products have been marketed, the Committee for Medicinal Products for Human Use has determined that the use of products Caustinerf arsenical, Yranicid arsenical, and other products intended for surface application is related to the risk of carcinogenicity and serious adverse reactions of necrotic nature, with potential consequences.

The Committee has determined that the potential genotoxic and carcinogenic effects, and harmful impact on reproduction related to systemic exposure to arsenic trioxide, combined with the lack of knowledge on the extent of systemic exposure during dental uses of toothpaste with arsenic are unacceptable. Furthermore, the Committee is of the opinion that the risk of tissue necrosis cannot be ruled out, even if dental procedures are performed with all due care and in accordance with the guidance provided in the SPC.

During the discussion, the actions proposed by the Marketing Authorization Holder to minimize risk were considered, such as amending the product information (restrictions of use, addition of contraindications for use in children and women

during pregnancy and breastfeeding), informational materials, and the PASS test. CHMP is of the opinion that the proposed actions will not be able to sufficiently reduce the risk related to the use of those products.

A review of the available data on efficiency (including data made available from the moment of granting the first marketing authorizations) has shown that the efficiency of Caustinerf arsenical, Yranicid arsenical, and other associated products for surface applications for registered indications is limited; there is no convincing evidence of the benefits for patients, in particular in the context of the current treatment strategy when the knowledge on pulp devitalization and analgesia is much broader and new, safer treatment options are available [12].

TREATMENT OF IRREVERSIBLE PULPITIS

There are numerous causes of dental pulp diseases; however, in the majority of cases, pulp diseases are secondary to dental caries. In the age of widespread consumption of carbohydrates and processed food, despite using the necessary anti-caries agents, the disease incidence is much higher than in the past. The most prominent group of etiological factors is infectious factors, i.e. cariogenic bacteria. Non-infectious factors include mechanical, thermal, and chemical stimuli [13]. For the dentist, it is crucial to determine whether the dental pulp can be kept alive, or must be removed.

In terms of diagnosis, the most challenging condition is irreversible pulpitis. The treatment of choice is pulp extirpation under local anesthesia, with immediate filling of root canals. If pulp extirpation is infeasible, the pulp is extirpated after prior devitalization. This is the case in patients who are allergic to local anesthesia and suffer from hemophilia. Despite the fact that the method is not perfect, it allows the dentist to keep the tooth in the mouth. However, it is characterized by a lower success rate that pulp extirpation under anesthesia. The main side effect of devitalizing agents is the damage to the tissue of the apical periodontium. The necrotic, infected pulp can also be potentially left in the branches of the root canal [13,14]. Such teeth are potential sources of infection and one of the etiological factors of focal diseases.

Pulp devitalization – advised against, yet still used

Pulp devitalization is usually the first step of treatment of irreversible pulpitis, if the dental pulp cannot be completely removed. For this purpose, dentists use special toothpastes, the main ingredient of which is a formaldehyde derivative – paraformaldehyde. It can take the form of formalin, a parapaste ingredient, or paraformaldehyde. As a xenobiotic, it has impact on the immune system even at low concentration levels. Paraformaldehyde can cause oversensitivity and suppression [15,16,17,18]. According to the Regulation of the Minister of Health of September 11, 1996, and the International Agency for Research and Cancer (IARC), formaldehyde has been classified as a corrosive and carcinogenic agent [19].

Paraformaldehyde, which is a product of the polymerization of formaldehyde, undergoes slow depolymerization in the tooth cavity. As a result, formaldehyde molecules gradually penetrate into the pulp, causing complete necrosis after 6–8 days. Exposed to formaldehyde, living tissue first undergoes irritation, followed by necrosis and mummification. The entire process is slow and follows a gradual depolymerization of para-formaldehyde in the tooth cavity, which reduces the risk of irritation of the periodontal fiber. Another important feature of paraformaldehyde is its ability to mummify the pulp and create a demarcation line on the edge of the periodontal fiber.

The disadvantage of paraformaldehyde is that patients suffer bouts of pain during application. Lidocaine used with paraformaldehyde in pulp devitalization eliminates the pain [12,20,21]. The National Health Fund in Poland refunds medical procedures with the use of those agents.

Methods of pulp extirpation after devitalization

In the past, mortal methods were used, consisting of partial removal of the devitalized pulp and leaving portions of the pulp tissue in one or more root canals. According to the current state of dental knowledge, the remainder of necrotic tissue may be a source of allergic and toxic factors that could trigger disorders in remote organs (such as the heart, kidneys, or eyes). Teeth with necrotic pulp are so-called infection foci. For this reason, methods based on partial removal of necrotic pulp are currently prohibited. If necessary, the only mortal method that is currently acceptable is extirpation. The procedure can be performed if extirpation under local anesthesia is infeasible due to an allergy to anesthetic agents, blood coagulation disorders, such as hemophilia, or lack of technical means to completely remove the pulp from the tooth cavity [11].

Mortal amputation of the pulp

In 1878, the method of partial pulp extirpation was first introduced, called mortal amputation. The method found wide application in treating multi-root teeth. Major criticism of the mortal amputation method appeared only in the past twenty years. Analyses of the vast clinical data, conducted by multiple authors, showed that in the majority of cases the method lead to periapical inflammation. That is because the necrotic tissue left in the root canals cannot be sterilized completely. All materials used to cover the pulp

remains lose their bactericidal effect over time. As a result, necrotic tissue left in the canals becomes the perfect medium for microbial growth [11]. Leaving necrotic tissue in the body is contradictory to the best medical practices in terms of the allergic theory of focal infection. As a result of the aforementioned criticism, mortal amputation of the pulp was dismissed as a treatment method in multiple countries. In cases where conservative treatment of pulpitis fails, the only acceptable method is now complete extirpation of the pulp.

For permanent teeth, the method should be considered interim; after the roots have formed, treatment by pulp extirpation should be initiated. Mortal amputation should then be considered a stage of extirpation treatment, rather than a separate method.

In other cases of pulpitis, the mortal amputation method may be applied only to multi-root teeth, if the root canals are blocked due to excessive curvature. In such cases, the combined method should be applied, i.e. extirpation of the pulp from patent root canals, and amputation to the curvature site in curved canals. Treatment should be performed in line with the principle that the more necrotic pulp is removed, the lower the risk of periapical lesions [11].

Mortal extirpation method

This method is based on the devitalization and complete extirpation of the pulp from the tooth cavity and root canals, and complete permanent filling of the tooth cavity. Mummification makes it possible to dry the pulp and detach it from the tooth walls, and to create a demarcation line in the form of a leukocytal bank separating both tissues. The bank increases the periodontal fiber's resistance to infection and injury, and makes it possible to detach the pulp at the right spot, and protects the periodontal fiber against damage [11].

Amputation & extirpation method

This method, referred to as a combination method, is applied in the treatment of multi-root teeth in the event of unmanageable blockade of one of the canals caused by excessive curvature of the tooth roots. In such cases, treatment is conducted according to the principle that the more necrotic tissue is removed from the canals, the lower the risk of periapical lesions [21].

COMPLICATIONS OF TREATMENT WITH PULP DEVITALIZATION

Incorrect use of devitalizing agents

Incorrect use of devitalizing agents is related to secondary pain, the drug filtering into the marginal periodontium, and irritation and inflammation of the periapical tissue.

Filtering of the devitalizing agent is counteracted by applying a complete temporary dressing to the cavity. In the times of arsenic paste, drug penetration through incorrectly applied dressing often caused extensive gum and bone necrosis, and necrotic bone protrusions. Irritation of the periapical tissue, caused by a devitalizing agent overdose, can be avoided by strictly following the dosing regimen. It is important to check the expiration dates of pulp devitalizing agents. The devitalizing agents damage the pulp and periodontal fiber tissue; as a result, the tissue loses its metaplastic properties and no longer serves as a barrier for pathogenic stimuli from the tooth cavity.

Due to so many negative effects of pulp devitalization, the devitalizing agents have been abandoned in modern endodontic practice for procedures under local anesthesia [11,13].

PULP DEVITALIZATION IN CHILD-REN

Dental caries and its complications are an important issue in children's dentistry. Maintaining complete dentition during the transition from deciduous teeth to permanent teeth efficiently prevents future malocclusion and ensures the correct development of occlusion, phonetics, and facial features, thus increasing the child's quality of life. Due to their specific structure, caries in deciduous teeth progress much more rapidly and the resulting complications are more difficult to manage [22,23,24]. Also, due to the fact that children are more challenging dental patients than adults, a more radical approach is necessary. For this reason, the treatment of choice of irreversible pulpitis in deciduous teeth, limited to the cavity pulp, is pulpotomy. This treatment method is based on removing the infected cavity pulp while maintaining the viability and function of the remaining cavity pulp [22].

The history of treatment maintaining the viability and function of dental pulp dates back to the 18th Century, when in 1756, Philippe Pfaff successfully performed direct pulp capping for the first time, using a small gold plate. In the past, this procedure was a highly specialized one, requiring a special set of skills. The introduction of Buckley's solution in the 20th Century revolutionized children's' dentistry. Further advancement came in the 1930s when Sweet proposed using a mixture of ZnO, eugenol, and formocresol in the treatment of pulp diseases in molar teeth.

The perfect agent should be antibacterial, biocompatible, nontoxic, have a beneficial effect on the pulp, and not disrupt the physiological resorption of the root. It has been determined that a measure of the therapeutic success of pulpotomy is the preservation of the majority of the root pulp, the absence of pain and signs of inflammation; the periradicular tissue is alive and healthy; there are no radiological signs, i.e. internal/external resorption; there are no periapical lesions or lesions in the tooth bud region. The majority of biological failures of

this treatment method is caused by incorrect qualification of the tooth for procedure, where irreversible pulpitis also affects the root pulp [25,26,27,28,29,30].

TREATMENT OF IRREVERSIBLE PULPITIS AND THE FOCAL DISEASE

The purpose of basic dental care, through proper mouth cavity hygiene, prevention, and caries treatment, is to prevent the development of irreversible dental pulpitis. Pulpitis may lead to the emergence of potential infection foci within the mouth cavity. A tooth with partially or completely necrotic pulp is an infection focus. Currently, there is no method of root canal treatment that would eliminate bacterial cells or necrotic pulp cells from all dentinal tubules of the main root canal system. The canal filling materials, although more and more efficient, still do not guarantee elimination of micro leaks in the canal and potential penetration of pathogens into the periapical tissue and further to the bone. A tooth undergoing proper root canal treatment, as well as the canal filler, can also be a potential infection focus. Therefore, patients who have dental treatment with the use of mortal or intravital methods planned should consult it with their GP to eliminate any pathogen sources in the event of a focal comorbidity.

CONCLUSIONS

Both methods of treatment of irreversible pulpitis – mortal (with the use of a devitalizing agent) and intravital (under local anesthesia) – despite the fact that neither of those methods is perfect and i.e. does not ensure complete recovery, are and will continue to be used in dental practice. Whether the dentist decides to apply the mortal or the intravital method depends mainly on the individual needs and the conditions in the patient's oral cavity.

Conflicts of interest

We declare that we have no conflicts of interest.

REFERENCES

1. Lanfranco LP, Eggers S. Caries through time: and anthropological overview. Contempory Approach to Dental Caries 2012;3:1-33.
2. Piętka T, Krzymański G, Domański W. Historyczny przegląd metod i narzędzi do usuwania zębów. Czas Stomat 2005; LVIII: 2 (Polish)
3. Willis A, Oxenham MF. The neolithic demographic transition and oral health: The Southeast Asian experience. Am J Phys Anthropol 2013 Oct;152(2):197-208.
4. Kucharzewski M, Sitek-Ignac N, Saran A, Stwora I, Wilemska-Kucharzewska K. Did Tutankhamun Have a Dentist ? The History of Dentistry in Ancient Egypt. 2017;55–61.
5. Forshaw RJ. The origin of the dental profession: dental disease and dentistry in ancient Egypt. Dent Hist 2011;54:39–54
6. Forshaw RJ. Dental health and disease in ancient Egypt. Brit Dent J. 2009 Apr;206(8):421–4.
7. Marion LR. Dentistry of ancient Egypt. J Hist Dent 1996;44:15–7.
8. Forrai J. The beginnings of dental caries and its treatments. Rev Clin Pesq Odontol Curitiba. 2009;5:187–92.
9. Blomstedt P. Dental surgery in ancient Egypt. J Hist Dent 2013;61(3):129–42.
10. Pacey L. Ancient mummies reveal impact of dental disease. Br Dent J. 2014 Jun;216(12):663.
11. Arabska-Przedpełska B, Pawlicka H. Endodoncja Med. Tour Press International 2003;241-3, 325p.
12. Committee For Medicinal Products For Human Use. Aneks II Wnioski naukowe i podstawy do cofnięcia pozwoleń na dopuszczenie do obrotu. CHMP Agenda. 2013:4–10.
13. Arabska-Przedpełska B, Pawlicka H. Endodoncja Med. Tour Press International; 2003. 61-66p. (Polish)
14. Jańczuk Z, Kaczmarek U, Lipski M. Stomatologia zachowawcza z endodoncją. Warszawa: Wydawnictwo Lekarskie PZWL; 2014, 536 p. (Polish)
15. Marek K. Choroby zawodowe. PZWL; 2001, 175p. (Polish)
16. Klimańska M, Mudzińska M, Jenerowicz D. The importance of exposure to contact allergens in patients with allergic contact dermatitis. Postępy Dermatologii i Alergologii 2011;3:203.
17. Obtułowicz K, Czarnobilska E, Czerwik J. Alergia IgEb zależna na formalinę. Objawy kliniczne i przyczyna ich indukcji. Alergologia Immunologia 2004;2:58.(Polish)
18. Stobiecki M, Obtułowicz K, Piotrowicz K. Alergia IgE zależna na formalinę. Alergia Astma Immunologia 2006;11(1):222. (Polish)
19. Pośniak M. Formaldehyd – metoda oznaczania. Podstawy i Metody Oceny Środowiska Pracy 1999;22:96-100. (Polish)
20. Mutschler E, Geisslinger G, Kroemer HK, Ruth P, Schafer-Korting M. Kompendium farmakologii i toksykologii Mutschlera. Medpharm Polska; 2008. 368p. (Polish)

21. Jańczuk Z, Barańska-Gachowska M. Zarys kliniczny stomatologii zachowawczej. PZWL; 1976. (Polish)
22. Herman K, Składnik-Jankowska J, Fita K. Current view on pulpotomy in primary teeth pulp diseases treatment. Dent Med Probl 2010;47(2):230-5.
23. Barańska-Gachowska M: Endodoncja wieku rozwojowego i dojrzałego. Wydawnictwo Czelej, Lublin; 2004. (Polish)
24. Cameron A, Widmer R. Stomatologia dziecięca. Wyd. II, Elsevier Urban & Partner, Wrocław; 2013.
25. Sonmez D, Sari S, Cetinbaş T. A comparison of four pulpotomy techniques in primary molars: a long-term follow-up. J Endod 2008 34(8):950-5.
26. Walker LA, Sanders BJ, Jones JE. Current trends in pulp therapy: a survey analyzing pulpotomy techniques taught in pediatric dental residency programs. J Dent Child 2013 Jan-Apr;80(1):31-5.
27. Ranly DM. Pulpotomy therapy in primary teeth: new modalities for old rationales. Pediatr Dent 1994;16(6):403-9.
28. Bala Prasanna Kumar C. Pulpotomy in primary teeth. A review. JIADS 2011;2:29-31.
29. Biondi AM, Cortese SG, Ortolani A. Pulpotomías en molares primarios. Revista de la Facultad de Odontología (UBA) 2008;23 (54/55):13-7.
30. Sweet CA. Treatment for deciduous teeth with exposed pulps. Mich St Dent J 1937;19:13.