Use of shock waves in dental medicine

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Introduction

The indications for the use of shock waves in musculoskeletal pathology are well established and, in many cases, there is solid scientific evidence [1].

In recent years, different publications have suggested the potential benefit of this technology in dental medicine [2-13]. There is a group of pathologies in which resolution usually involves complicated procedures and surgical approaches in which shock waves could reduce not only complications but also costs. Its many effects, such as bactericide, induction of neovascularization, modulation of inflammatory processes and stimulation of osteogenesis, can be very useful in dental pathology [14-16].

The aim of this presentation is to review the literature and to analyze the possible indications in dentistry.

Materials and Methods

1. Search strategy

Electronic search was conducted independently by two authors (C.P.G. and D.M.) in five major databases (Pubmed, Scielo, Cochrane, Digital Library of the Universidad Complutense de Madrid and Google Scholar).

2. Eligibility criteria

The inclusion criteria were articles in English and Spanish, full texts and abstracts published between 2001 and 2022.

We included systematic reviews, meta-analyses, experimental studies, clinical studies, case reports, and letters to the Editor related to the use of shockwaves in dental medicine.

The keywords used in the search where: "Shock waves + Dental", "Shock waves + Implantology", "Shock waves + tooth", "Shock waves + periodontics".

We excluded articles not related to dentistry and specifically those related to sialolithiasis in parotid and submandibular glands.

Results

Following the criteria described, we finally found 43 publications. According to the type of publication, 2 were systematic reviews [11,12], 8 reviews of the literature [3-10], 26 experimental studies (3 in vitro [14-16], 18 in rats [17-34], and 5 in rabbits [35-39]), 6 clinical studies in humans [40-45], and a letter to the Editor [13].

Five publications describe the general characteristics of shock waves and their potential applications in dental medicine [3,5,7,8,11].

Among the experimental studies, 2 demonstrated the bactericidal effect of shock waves [15,16], one evaluated the effect on pulpal blood flow [43] and three on the dose-related effect on cytokines [14,24,26].

Thirteen studies analyzed the effects of shock waves on osteogenesis, osseointegration and bone healing [9,17,21,22,30-33,35,37-40], two of them were related to maxillary fractures [17,40].

The effects on distraction osteogenesis were specifically evaluated in 5 publications [21,30,35,37,38].

The effect of shock waves in orthodontic tooth movement was studied in 12 publications [18,19,23-29,36,42,44]. Two publications were directly related to the use of shock waves in periodontitis [10,20] and two in peri-implantitis [6,13].

One study evaluated the effect of shock waves on the stability of orthodontic temporary anchorage devices (TADs) [41].

Five publications reported the absence of evident clinical changes after the application of the waves (one experimental study in rabbits [38] and four in humans [41-43,45]). An experimental study evaluated the possibility of adverse effects from the application of shock waves in rats [34].

Discussion

There is great interest in the potential benefit of the use of shock waves in dental medicine. It has been shown in an experimental study that the use of oral shock waves is safe.

Although there are reports of no

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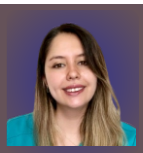
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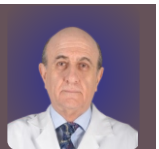
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improvement after the application of shock waves [38,41-43,45], other experimental and clinical studies have shown positive results [5,11,17-23,29-33,37,39,40,44]. The difference in results may probably be due to the use of different application protocols, it has been demonstrated that shock waves effect is clearly linked to the dose used.

The main possible indications for shock waves in dental pathology are:

1. Periodontitis: Periodontitis is a chronic inflammatory gum disease triggered by bacterial microorganisms [46]. It leads to the destruction of the tooth-supporting apparatus (periodontal ligament and alveolar bone) and can lead to tooth loss.

It is caused by bacterial biofilm and not by planktonic pathogens [3,47]. Biofilms are communities of bacteria attached to surfaces. Whereas planktonic bacteria are designed to colonize new niches, but with a lower chance of survival, bacteria in a biofilm provides a more secure way for bacteria to reproduce and survive [48]. This explains, in part, biofilm's increased tolerance against antibiotics, disinfectants and the immune system. The emergence of antibiotic tolerance and resistance in biofilms is a major cause of concern [49]. Several in vitro studies have suggested that shockwaves may be bactericidal for selected oral bacteria [15,16]. Olivares [16] in a recent paper stated that shockwaves may be a potential treatment for Streptococcus Mutans Biofilms.

Datey et al [20] demonstrated that shockwave treatment in combination with antimicrobials is significantly effective in clearing a multispecies biofilm. Furthermore, the authors showed that following the treatment, the animals treated with shock waves or antimicrobials alone did not recover from the disease significantly.

Shockwaves´ antibacterial efficacy, especially to the periodonto-pathogens, potential to induce alveolar bone regeneration and rapid periodontal remodeling, combined with anti-inflammatory, analgesic and tissue-regenerative properties with minimal or no documented side effects, provide a substantial backing for its potential to be implemented in conventional mechanical periodontal therapy.

2. Periimplantitis: is considered a site-specific infectious disease that causes an inflammatory process in soft tissues, and bone loss around an osseointegrated implants [50]. Smoking and a history of periodontitis have been associated with a higher prevalence of peri-implantitis [51].

Shock waves could play an important role in the treatment of perimplantitis. In 2009 Li et al [6] reported that shock wave therapy may be an adjuvant treatment for peri-implantitis by controlling infection, inducing alveolar bone regeneration and promoting re-osseointegration. Osseointegration in dental implants is defined as the tisular and functional relationship between structured viable bone and the surface of a functionally loaded implant [52].

3. Endodontics: Endodontics is the branch of dentistry concerned with diseases and injuries of the soft tissues inside a tooth (the dental pulp). The pulp mass is a highly vascularized and innervated mass of connective tissue that resides within a spaced called the pulp chamber [53]. Various cell types characterize this tissue, including fibroblasts, odontoblasts, histiocytes, macrophages, mast cells, and plasma cells. the main four functions of the pulp are formation and nutrition of the dentin, as well as the innervation and defense of the tooth [53].

Falkensammer et al[43] assessed the pulpal blood flow after a single treatment of ESWT, (4 times/6months) using a laser Doppler device. The findings of this study indicated a transient elevation of pulpal blood flow in the treated group with no significant difference compared to the control group over the study period of 6 months.

The authors applied 1000 impulses of focused ESWT at an energy flux density of 0.19–0.23 mJ/mm2. Is this the right dose? There is still no consensus regarding the ideal therapeutic dose.

4. Orthodontics: Another field of dentistry in which waves may have potential utility is orthodontics. Orthodontics is the division of dentistry dealing with the prevention and correction of mal-postioned teeth [54]. Falkensammer et al [42] reported in 2014 that a single application of extracorporeal shock wave treatment was associated neither with a statistically significant acceleration of tooth movement nor with an altered periodontal status in vivo. Again, this is an "in vivo" study in humans as opposed to experimental studies done in animals. Was the dose used adequate?

Hazan- Molina [29] referred that when compared to orthodontic force on its own, ESWT adds to the orthodontic power more than its double-speed of tooth movement in a rat model.

Demir and Arici [36] in an experimental Study in rabbits found that the application of extracorporeal shock waves, especially with a focused applicator, could accelerate orthodontic tooth movement.

Falkensammer [41] reported that ESWT had no positive effect on improving the stability of TADs compared to placebo participants.

Ahmed et al [40] compaired the effect of adjuvant LIPUS and ESWT in healing in patients with fresh mandibular fractures. They concluded that ESWT is a safe and efficient treatment for fracture healing because it can enhance bone mass density, promote blood flow and metabolic activity in the adjacent soft tissue, and play a key role in pain relief.

A pilot study on rats indicated that combined intermaxillary fixation and ESWT reduces the duration of improvement in subcondylar mandibular fractures [17]. ESWT could reduce the concomitant complications of lengthy fixation such as ankylosis, fibrosis, and hypomobility.

In a distraction osteogenesis rabbit model, a study proved that ESWT could stimulate growth factors and enhance the formation of new osteogenesis [35].

Conclusion

There is a growing interest in the area of dental medicine regarding the benefits of using shock waves. Most of the studies currently available are experimental in vitro and in animals. There is a significant number of potential indications.

The implementation of effective application protocols and the development of randomized clinical studies with a high level of evidence with long-term follow-up will allow us to discover the usefulness and limits of this therapeutic tool in the field of dental pathology in the future.

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Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has/her given his-her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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