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Review Article

Traditional Anti-Inflammatory and Bone Regenerative Herbal Extracts in Orthodontic Patient Care - A Review of the Current Scenario and its Future Needs

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Abstract

Orthodontics is a speciality in dentistry dedicated mainly to move the teeth through the bone. The objectives of orthodontic treatment according to Jackson's triad are structural balance, functional efficiency, and aesthetic harmony. Nature has always contributed a good source of foods and ingredients that are beneficial to human health. The present review thus places an interest in enumerating the methodical evidence on naturally present compounds extracted from potent traditional herbs, which are known to possess anti-inflammatory and enhance bone remodeling activity which are the crucial parameter to be kept under control during orthodontic treatment and the novel extracts are enumerated.

Keywords: Traditional; Herbal Extracts; Root Resorption; Bone Remodeling

Introduction

Orthodontics is a speciality in dentistry dedicated mainly to move the teeth through the bone. The process of moving teeth in the dentoalveolar complex is a coactive sequence of physical phenomenon and biological tissue remodelling [1]. Orthodontic tooth movement is a process that combines physiologic alveolar bone adaptation to mechanical strains with minor reversible injury to the periodontium [2]. Orthodontic tooth movement will be established through the process of remodelling in the periodontal tissue and subsequently changes can be seen in cementum and alveolar bone. When orthodontic force is applied, the pressure induces osteoclastic mineralized tissue degradation on the compression side and mineralization by osteoblasts on the tension side [3]. The balanced activity of osteoclasts and osteoblasts plays a fundamental role in this respect [4].

The objectives of orthodontic treatment according to Jackson's triad are structural balance, functional efficiency, and aesthetic harmony. Many young people who have undergone orthodontic treatment report higher levels of self-esteem and their quality of life are often significantly improved. Despite of many advantages this procedure, can also cause problems like decreased stability of the teeth, reduced marginal attachment and resorption of root structure as well as underlying alveolar bone as a side effect [5]. External apical root resorption (ARR) is an undesirable complication of orthodontic treatment, which results in permanent loss of tooth structure from the root apex [6]. It is caused when extreme orthodontic force is applied which brings sterile inflammation, results in cell free zone in the periodontium, eventually causes removal of superficial root cementum and subsequently the underlying dentin and alveolar bone [7]. Previous studied have reported that, about 80% of subjects, who undergo orthodontic treatment may represent with some amount of apical external root resorption [8].

Numerous research studies have explored risk factors associated with ARR in an effort to understand underlying mechanisms and develop prevention strategies and treatment methods. These studies suggest that the aetiology of ARR is multifactorial and includes patient-related and treatment-related risk factors. ARR is associated with a variety of patient-related risk factors that include age, gender, severity of malocclusion, tooth and root morphology, as well as systemic conditions such as allergy, asthma, and alcoholism. Among the treatment-related risk factors for ARR, magnitude of orthodontic force, direction of tooth movement, and apical displacement are important factors [9].

Diagnosis of ARR is done both radiographically and by quantitative assessment of biomarkers. The radiographic diagnosis includes conventional two-dimensional (2D) radiographs like intra oral periapical radiographs, Orthopantomography, Lateral cephalography and digital radiography. However, ARR affects all dimensions of root surface therefore the use of 2D radiographs will have limited application as the true extent of ARR might be mis estimated due to magnification errors and problematic repeatability [10]. With the introduction of Cone beam computed tomography (CBCT) to the dentistry, it enables accurate quantification of both linear and volumetric ARR measurements and compensates for changes in root position or angulation during orthodontic treatment. On the other side, substantial increased radiation dose during the use of CBCT when compared to 2D radiographs and same might be as much as 15-fold difference between a low-dose and a high-resolution protocol with the same field of view [11].

The other indicator for ARR is to measure the bone biomarkers. Bone biomarkers are biomolecular substances formed during the process of bone remodelling which can be categorized into three subdivisions like bone formation biomarkers, bone resorption biomarkers and regulators of bone turnover. Detections of bone metabolism have been studied with the biomarkers of enzymes, proteins and by-products during the bone remodelling process [12-14]. The bone formation biomarkers are total alkaline phosphatase (ALP), bone-specific alkaline phosphatase (BALP), osteocalcin (OC), procollagen type 1 N-terminal propeptide (P1NP) and procollagen type 1 C-terminal propeptide (P1CP). The bone resorption biomarkers are hydroxyproline (HYP), hydroxylysine (HYL), deoxypyridinoline (DPD), pyridinoline (PYD), bone sialoprotein (BSP), osteopontin (OP), tartrate-resistant acid phosphatase 5b (TRAP 5b), carboxy-terminal crosslinked telopeptide of type 1 collagen (CTX-1), amino-terminal crosslinked telopeptide of type 1 collagen (NTX-1) and cathepsin K (CTSK). The regulators of bone turnover are receptor activator of NF-kB ligand (RANKL), osteoprotegerin (OPG), dickkopf-1 (DDK-1) and sclerostin. These biomarkers are useful to provide the early assessment of osteoporosis when the BMD measurement of DXA does not offer enough information to make the diagnosis [15].

The conclusions from many studies revealed that active orthodontic force will have greater impact on root resorption. Hence the repair process of root resorption takes place only after the completion of active orthodontic treatment. The process of repair of cementum after orthodontic treatment is more or less similar to early cementogenesis, Owmann Moll., *et al*. summarized the histological stages of repair level as follows [16-18]

- **Partial Repair:** Part of the surface of the resorption cavity is covered with reparative cementum (cellular or acellular cementum).
- **Functional Repair:** The total surface of the resorption cavity is covered with reparative cementum without the re-establishment of the original root contour (cellular cementum).
- **Anatomic Repair:** The total surface of the resorption cavity is covered with reparative cementum to an extent such that the original root contour is re-established.

Whereas Cheng., *et al.* found that resorption continued for 4 weeks after the stop of the orthodontic force. After four-week light force application which was followed by 4-week retention, there was continuous and regular repair, while most of the repair occurred where the heavy force was applied in 4 weeks, which was followed by the 4-week retention [19].

Clinicians must conduct a detailed history and investigate probable predisposing factors and clinical problems before beginning treatment. Because root resorption is a concern for doctors, they must inform patients and their parents about the potential repercussions of orthodontic treatment. According to research, orthodontic patients are more prone to experience root resorption. It's critical to comprehend the role of orthodontics in root resorption. Despite breakthroughs in the genetic basis of bone resorption, therapeutic advances in bone resorption care have yet to be revealed. To further understand the biology, identification, and treatment of this unwelcome consequence, large-scale multi-center clinical research are required [20,21].

Novel traditional herbal extracts as a remedy for passable bone remodeling and root repair

Nature has always contributed a good source of foods and ingredients that are beneficial to human health. Presently the researchers and clinician are increasingly focusing on the research which includes herbal extract to swap synthetic compound products, which are largely considered to have adverse reactions like toxic and carcinogenic effects. The green extraction of those compounds from their herbal reassets and the dedication in commercialized merchandise had been tremendous demanding situations for researchers. The present review thus places an interest in enumerating the methodical evidence on naturally present compounds extracted from potent traditional herbs, which are known to possess anti-inflammatory and enhance bone remodeling activity which are the crucial parameter to be kept under control during orthodontic treatment and the novel extracts are enumerated in table 1.

Sl no.	Plant (Family)	Parts used	Extract	Immunomodulating properties	Native Place of the plant
1.	Astragalus membranaceus (Fabaceae)	Roots	MeOH extract	Inhibits production of IL-6 and IL-12	Northern hemisphere. It is native to Mongolia, Korea and China.
2.	Cimicifuga racemosa (Ranunculaceae)	Roots and rhizomes	Iso-propanolic extract	Suppresses TNF-α production	North America.
3.	Cryptolepis buchanani (Asclepiadaceae)	Roots	Ethanolic extract	Stimulates delayed type hypersensitivity reaction and humoral antibody production	Indian subcontinent
4.	Curcuma longa (Zingiberaceae)	Rhizome	Ethanolic extract	Decreases levels of TNF-α, IL-1 and IL-6	Indian subcontinent and Southeast Asia
5.	Cissus quadrangularis (Vitaceae)	Stem	Ethanolic extract	Increases phagocytic index and serum immunoglobulin levels	Bangladesh, India and Sri Lanka.
6.	Commiphora molmol (Burseraceae)	Resins	Ethanolic extract	Reduce production of prostaglandins &increase IL6	Arabian Peninsula and Africa
7.	Drynaria baronii/ Drynaria fortunei (Polypodiaceae)	Rhizome	Aqueous and MeOH extracts	Reduces expression of RANKL and NF-κβ	East Asia, Southeast Asia, Australia, Africa, South Asia and Oceania
8.	Epimedium leptorrhizum (Berberidaceae)	Leaves	Aqueous extract	Anti-inflammatory by inhibiting the production of NO, IL-1β and IL-6.	China

Table 1: Novel Traditional herbal extracts which possess bone and root healing during orthodontic treatment.

Astragalus membranaceus (Family: Fabaceae)

Traditional Chinese medicine has used it for ages to treat a variety of ailments, such as Wound healing, diabetes, leukemia, hypertension, eye illness, nephritis, cirrhosis, and uterine cancer are just a few examples. Many phytochemistry and pharmacological research in recent years have revealed that the polysaccharide component of Astragalus membranaceus is one of the most important bioactive components. Immune modulation, anti-inflammatory, anti-oxidation, anti-glomerulonephritis, anti-atherosclerosis, anti-diabetes, and anti-tumor properties are among its many health advantages [22]. In current studies, it has been proved that formononetin; a bioactive phytoestrogen constituent of this plant is a favorable agent for the inhibition of osteoporosis [23]. Formononetin encourages angiogenesis and osteogenesis via the inhibition of osteogenic markers expression and inflammatory cytokines, thereby additionally stopping osteoarthritis with the aid of using promoting increase issue activation, endothelial restore and wound healing [24].

Cimicifuga racemosa (Ranunculaceae)

Cimicifuga racemosa additionally referred to as Actaea racemosa, normally referred to as Black cohosh, Bugbane, Bugroot, Snakeroot, Fairy candle, Rattle root, Black root and Black snake root, is a local to North America. It is used withinside the remedy of osteoporosis and further bone associated problems such as osteomyelitis [25]. Cimicifuga racemosa additionally referred to as Actaea racemosa, normally referred to as Black cohosh, Bugbane, Bugroot, Snakeroot, Fairy candle, Rattle root, Black root and Black snake root, is a local to North America. It is used withinside the remedy of osteoporosis and further bone associated problems such as osteomyelitis [26,27].

Cryptolepis buchanani (Asclepiadaceae)

In India, it is commonly known as Harjoralata and Krishna Anantamul (Assamese), Karanta (Hindi), Kalasariba (Bengali), Jambasariba Khasi Kombatugiang and Garo Darikhal (Sanskrit). In Thailand, C. buchanani is known as "Thao En on" [28,29]. This plant is known as "gangron" and its fluid extricate treats breaks within the East Cyan area of Arunachal Pradesh [30]. Plant root ethanol extricate (95%) features a solid immunostimulatory impact. Verbal organization of causes diminished discharge of TNFα, postponed touchiness response, and humoral counter acting agent generation [31]. The study on Cryptolepis buchanani revealed that the decrease of tumor corruption factor-alpha (TNF-alpha) discharge from LPS-stimulated human monocytic cell line (THP-1) was moreover illustrated in cells that were pre-incubated with the extricate [32]. An additional important feature of Cryptolepis buchanani is its low toxicity, especially by oral treatment, which significantly encourages clinical trials of this extract in the human.

Curcuma longa (Zingiberaceae)

An aromatic, herbaceous perennial herb, extensively cultivated in southeast Asian international locations like India, Bangladesh, Sri Lanka Pakistan, Myanmar, Indonesia, Madagascar, Laos, Vietnam, Cambodia, and Taiwan [33]. In Ayurveda, the rhizome is taken into consideration hot, bitter, pungent, astringent and dry component with lot of medicinal use. Curcumin, the primary energetic constituent found in rhizomes of C. longa improves each the bone microarchitecture through activation of microRNA-365 through regulating matrix metalloproteinase (MMP)-9 (81) and mechanical energy of bones through decreasing serum estradiol ranges in non-ovariectomized rats with everyday estrogen ranges, thereby growing cancellous bone formation, however in case of ovariectomized rats curcumin barely boom a few bone histo-morphometric parameters impaired through estrogen deficiency [34]. Curcumin management has been suggested to lower the stages of numerous proinflammatory cytokines viz. IL-1, IL-2, IL-6, TNF-α and MIP1α and lowering NF-κB activity, thereby reducing inflammatory responses [35].

Cissus quadrangularis (Vitaceae)

Cissus quadrangularis (CQ) is regularly recognized as Asthi Samhara in Sanskrit (meaning reconciliation of bone), in English it generally called as Veldt Grape or Devil's backbone [36]. It is considered to one of the most important tradition herbal extracts in improving bone strength by enhancing osteogenesis [37]. A study reported that the CQ showed protected bone mass and microarchitecture of trabecular bone in animal study done on the rat. The reason for the same may be due to reduced inflammation and modulation of healing process through BMP and Wnt signaling pathways. They have also concluded that CQ can be a potential medicine to strengthen bone with no significant adverse effect [38]. A pilot study was done on six patients to test the efficacy of CQ in reducing pain, swelling and improving bone healing and the study revealed that there was reduction in pain and swelling when compared to control group and there was significant increase in Alkaline Phosphatase level which in turn contribute to enhanced bone healing [39].

Commiphora molmol (Burseraceae)

Commiphora molmol it is a gum resin extracted from the stem part of the plant [40]. The oleo gum resinous exudate extracted from Commiphora molmol is commonly known as Myrrh, showed potent antibacterial, antiseptic, antiparasitic, antitussive and antioxidant property with no significant side effects [41].

Drynaria baronii/ Drynaria fortunei (Polypodiaceae)

Drynaria fortune is an old Chinese herb Gusuibu, commonly used for the treatment and prevention of bone related disease [42]. Drynaria is also used to facilitate bone healing in stress fractures, knee pains and tooth related diseases [43]. An animal study found that the use of Drynaria extract promote osteoblast maturation there by improving the bone strength in mice [44].

Epimedium leptorrhizum (Berberidaceae)

Epimedium leptorrhizum is commonly known as Chinese herbal medicine for more than 2000 years. Studies have revealed good curative effects for sexual dysfunction, osteoporosis, cardiovascular diseases, menstrual irregularity, asthma, chronic nephritis, cancer, decreased immunity [45]. Its flavonoids have estrogen-like activity, thereby causing regulation of bone metabolism via the estrogen receptor pathway, with ALP activity and IL6, OPG (osteoprotegerin), MCSF, RANKL, BMP2, Cbfα1 (core binding). It further enhances osteoblast formation by increasing expression factor alpha subunit) 1) and SMAD4 (protein) involved in bone remodeling [46].

Conclusion

The increased use of traditional herbal extract to treat different oral disease to overcome disadvantages of chemical drugs made researcher to do extensive studies related to the same. The current evidence suggests that there are many traditional herbal extracts are available to improve the bone healing and remodeling, so further research is indicated to prove the efficacy of traditional extract to avoid and improve the external apical root resorption.

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