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Research on the clinical application of autogenous tooth bone graft material

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Abstract: *Autogenous tooth bone graft material is made from patients' own useless teeth. Many animal experiments and clinical studies have confirmed that it has good osteoinductivity, osteoconductivity, biocompatibility and other characteristics. This article describes the development and application of autogenous tooth bone graft material.*

Keywords: *demineralized dentin matrix, bone graft material, osteoinductivity, osteoconductivity*

1. Introduction

Periodontal disease, periapical disease, cyst, trauma, etc. can cause oral and maxillofacial bone defects, which are usually repaired with bone graft materials [1-3]. The ideal bone graft material should have good characteristics of osteogenesis, osteoinductivity, osteoconductivity, biocompatibility, biodegradability and so on. Osteogenesis refers to the fact that phalanx graft material contains osteoblasts or osteoprogenitors, which secrete bone matrix to form new bone. Osteoinductivity is the formation of new bone by stimulating the differentiation of mesenchymal stem cells into osteoblasts and chondrocytes from the surrounding bone graft by molecules in phalange-bone graft materials, such as bone morphogenetic proteins. Osteoconductivity is that the phalangeal bone graft material provides a scaffold or guide for the growth of blood vessels and the formation of new bone, which enables cells from neighboring tissues to enter the bone graft material and then form new bone. Biocompatibility means that phalangeal graft materials can interact with the host without being rejected or destroyed. Biodegradability means that phalangeal bone graft materials can be biodegraded after implantation in the body, and the rate of biodegradation should match the rate of new bone formation. If the material degrades too quickly, the bone defect area will collapse; if the material degrades too slowly, the new bone formation will be hindered. The material should also have good mechanical strength to maintain the stability of the bone graft area [4-5].

The commonly used bone graft materials have their own advantages and disadvantages. Autologous bone is derived from patients themselves, which has osteogenesis that other bone graft materials do not have, and has good osteoinductivity, osteoconductivity, and biocompatibility. Autologous bone has long been considered as the gold standard for bone defect reconstruction, but there are problems such as limited bone mass, increased donor site trauma, and faster absorption after implantation. Allogeneic bone from different individuals of the same species has good osteoconductivity and a small amount of osteoinductivity, but has disease transmission risk and immunogenicity problems. Xenograft bone comes from a variety of species, such as Bio-Oss bone graft material, a deproteinized bovine bone substrate that has good biocompatibility and osteoconductivity, but lacks osteoinductivity and may suffer from slow absorption. Synthetic bone graft materials, such as bioactive glass, have good biocompatibility and osteoconductivity, but are not osteoinductivity and slow absorption. Currently, the research on bone graft materials is in the ascendancy [6-9].

Clinically, reimplanted teeth and transplanted teeth have the risk of root displacement absorption, and bone tissue gradually replaces the absorbed roots [10-13]. During wisdom tooth extraction, the root may occasionally break and remain in the extraction socket, which usually does not cause inflammatory reaction [14]. The immediate implantation technology of dental slice barrier means that a part of the labial root is retained during tooth extraction, and then immediately implanted, so as to maintain the alveolar bone volume of the labial and maintain the outline of soft and hard tissues, and meet the aesthetic requirements [15-17]. All this suggests that teeth are a potential bone graft material.

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2. Demineralized dentin matrix

The bone forming power of teeth comes mainly from dentin, Mature dentin contains 70% inorganic matter, 18% collagen, 2% non-collagen and 10% water. Inorganic substances are composed of five different kinds of biological calcium phosphate, including hydroxyapatite, tricalcium phosphate, octacalcium phosphate, amorphous calcium phosphate and dehydrated dicalcium phosphate. They can be used as scaffolds for cell attachment and proliferation, and have good osteoconductivity, bone remodeling ability and certain mechanical strength. Collagen interweaves into a network and acts as a scaffold for cell attachment and proliferation. Non-collagen proteins include bone morphogenetic protein, osteocalcin, and transforming growth factor- β、 Vascular endothelial growth factor can play a role in osteoinductivity. The existence of dentin tubules is conducive to the release and transmission of growth factors [18].

Studies on odontogenic bone graft materials began in the 1960s, and some scholars found that DDM was osteogenic and could induce osteogenesis in ectopic position [19]. Since then, several studies have confirmed that demineralized dentin matrix can be used as a bone graft material. Developed on the basis of DDM research, autogenous tooth bone graft material is made from patients' own useless teeth [20]. In 2003, some scholars reported for the first time the successful case of clinical application of autogenous tooth and bone meal in maxillary sinus lifting [21]. In 2007, Japanese scholars invented tooth grinding machine, which made the production of autogenous tooth and bone meal more convenient [22]. In 2009, the Korea Tooth Bank was established to collect and store teeth and prepare them into bone grafts[23].

3. The clinical application of autogenous tooth bone graft material

Autogenous tooth bone graft material can be applied in granular, block and flake form.The existence of wisdom teeth often leads to bone defects and periodontal pockets in the distal part of the second molar [24-25]. Sanchez-Labrador et al. [26] implanted autogenous bone powder made from extracted wisdom teeth into the extraction fossa. Clinical examination and imaging evaluation results of 6-month follow-up showed that the experimental group was superior to the blank control group in terms of the reduction of distal exploration depth of second molars and the increase of alveolar ridge height. Upadhyay et al. [27] used autogenous tooth and bone meal to treat second-degree bifurcated root lesions, and the 1-year follow-up showed that the probing depth of the bifurcated root area decreased and bone density increased. Autogenous tooth transplantation is a method to repair missing teeth [28]. TAZAKI et al. [29] reported a case of a patient with autogenous dental transplantation who underwent simultaneous autogenous dental bone meal to repair the atrophy jaw for the benefit of implant. The follow-up was 13 months, and the function of the implant was good. Pang et al. [30] used autogenous bone meal to implant bone increments and stages of alveolar ridge defects, and compared it with Bio-Oss bone meal. There was no significant difference in the proportion of new bone, the proportion of remaining graft material and the stability coefficient of implant between the two groups. Li Peng et al. [31] compared the clinical efficacy of autogenous bone meal and Bio-Oss bone meal for guided bone regeneration and immediate implantation, and the clinical and imaging results of 18 months 'follow-up showed that there was no significant difference between the two groups in terms of implant stability coefficient and bone resorption around the implant.

The tooth is prepared to match the shape and size of the bone defect area, and the bone block can be perforated to facilitate the contact between the bone block and the reagent, as well as the growth of blood vessels and osteogenesis [32-33].Schwarz et al. [34] evaluated and compared the effectiveness and safety of using autogenous and autogenous bone blocks for alveolar ridge widening. 26 weeks after surgery, there was no significant difference in alveolar ridge width between the two groups, and all implants were successfully implanted and achieved good initial stability. However, because the autogenous bone blocks were absorbed faster than the autogenous bone blocks, the autogenous bone blocks could better maintain the contour and volume of the bone graft area. The increase of the alveolar ridge width in the autogenous bone block group was 5.53±1.88mm larger than that in the autogenous bone block group was 3.93±1.41mm, and the difference was statistically significant. Shejali[35] et al. used autogenous dental bone blocks combined with synthetic bone grafts for site preservation, and the width of the 6-point crescent ridge increased significantly after surgery. All implants were successfully implanted and achieved reliable initial stability, without additional bone grafting at the implant site.

Bone shell technique is a three-dimensional bone reconstruction method. Thin and hard autogenous bone is used as a shell to fix the bone defect area, and the shell is filled with loose and porous granular

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bone graft material, so as to improve the stability of the bone graft area and obtain a good osteogenic environment. The autologous dentin shell technology is derived from the bone shell technology. The useless teeth of the patient are used to make dentin sheets through simple and effective chair side operation, which are fixed in the bone defect area as the shell, and granular bone graft materials are filled into the space inside the shell to achieve the purpose of bone increment [36-37]. Shuyi Li et al. [38] evaluated the clinical effect of non-demineralized autologous dentine shell for implant restoration in the aesthetic area of anterior teeth. The average increase of horizontal bone mass was 5.29±2.03 mm 4 months after the bone increment, and the red and white aesthetic scores were 8.09±0.70 and 8.91±0.54 after 1 year of follow-up. Good aesthetic effect and implant stability were obtained. According to a retrospective study, after implant implantation, partial demineralization of autologous dentine shell was fixed on the bone defect, and partial demineralization of autologous dentine particles was filled in the space between the dentine shell and implant, and the stability coefficient of all implants was over 60 three months after surgery, and complete bone integration was achieved [39]. It is worth noting that autologous dental bone fragments made from autologous dental root can also be used for bone increment, but they are easily limited by the size of the tooth root. In addition, compared with autologous dental bone fragments, the dentin particles filled between the dentine shell and the bone defect area have better blood circulation reconstruction and regeneration ability. Autogenous dental bone graft material and autogenous bone have similar physical and chemical properties, and the absorption of autogenous dental bone graft material is slower than autogenous bone, which can maintain the graft volume for a long time [4]. The absorption rate of autogenous dental shell is also not as fast as that of autogenous bone shell. Michael et al. [36] compared the clinical efficacy of partially demineralized autogenous dentin shell with autogenous bone shell for alveolar ridge enhancement and simultaneous implantation. In the experimental group, partial demineralized autogenous dentin shell was fixed in the operative area, and the gap between the dental shell and alveolar bone was filled with partial demineralized autogenous dentin particles, while in the control group, autogenous bone shell was fixed in the operative area. The space between the bone shell and alveolar bone was filled with granular autogenous bone, and all implants achieved complete bone integration. Wenlan Xiao et al. [37] compared the effect of non-demineralization autologous dentine shell and autologous bone shell in repairing alveolar bone defects, and the histological and imaging results showed that the absorption of dentine shell occurred and the combination of new bone and dentine shell occurred 24 weeks after the operation. There was no statistical significance in the vertical bone incremental effect between the two groups.

4. Conclusion

In conclusion, autogenous tooth bone graft material has the characteristics of osteoinductivity, osteoconductivity and biocompatibility, which is easy to obtain, economical and effective, and has a broad development prospect. However, existing studies have considerable heterogeneity in study design, materials preparation and use methods, as well as shortcomings such as small sample size and short follow-up period. Therefore, more high-quality animal experiments and randomized controlled clinical trials are still needed.

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