Application of Nanotechnology in Oral Implantation Based on Exercise-Induced Tooth Injury

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Abstract: With the development of sports in various countries, more and more people participate in sports, and the rate of sports injuries to the oral and maxillofacial system also increases, especially the dental injuries caused by boxing are more common. At the same time, with the improvement of modern production, people's basic needs have been continuously met, and more and more people have begun to pay attention to their physical health and appearance characteristics. Among them, dental plastic correction and restoration have received great attention. In addition, with the application of nanotechnology in various fields in recent years, scholars at home and abroad have also tried or have continued to introduce nanomaterials into oral clinics, in order to improve and develop the application of oral materials, so that the oral clinic can be continuously improved and developed. Therefore, this paper reviews the current situation of sports injury of the oral and maxillofacial system, the mechanical analysis of tooth injury, the current situation of tooth restoration and the application of nanotechnology in the field of oral implantation.

Keywords: Sports; Alveolar Bone Injury; Nanotechnology; Oral Implantation

1. Introduction

In maxillofacial injuries, the injury to the teeth caused by boxing is more common . According to the author's statistics, among the 770 maxillofacial injuries, 174 (22.60%) were dental injuries. Oral soft tissue injury is easy to bleed, and it is necessary to stop the bleeding in time. Tooth fractures are common in clinical practice, and different degrees of damage are difficult to repair, and the results are also different. Common restoration methods include removable dentures, fixed bridge braces and dental implants, among which dental implants are currently the most popular and suitable treatment for broken teeth. Tooth damage is mainly reflected in oral soft tissue damage, tooth fracture, alveolar bone fracture and tooth dislocation. The alveolar bone is a part of the skeleton of the whole body. The decrease in the bone density of the alveolar bone can weaken the structure of the jawbone and cause fractures easily. When oral and maxillofacial trauma is caused by sports and other reasons, the risk of anterior tooth loosening, dislocation and alveolar bone injury increases, and it is more common in clinical practice. However, due to insufficient bone mass during the treatment, the replantation in the operation area is often unsuccessful, or the denture repair in the later defect area is difficult to obtain effective support, resulting in decreased occlusal function and damaged appearance. If artificial bone can be used to repair the defect in time after trauma, it is expected to improve the height and fullness of the alveolar bone, establish a bony support structure, and create conditions for later denture repair or dental implantation .

1.1 Current status of oral and maxillofacial movement injuries

The oral cavity and maxillofacial region are the beginning of the respiratory tract and digestive tract, connected to the skull above and the neck below. The upper and lower jaws are the main skeleton, with teeth and tongue, rich blood supply,

and the trigeminal nerve and facial nerve are distributed in it. These special anatomical and physiological structures are the important basis for the injury characteristics of this part.Oral and maxillofacial injuries are also common in clinical practice, mainly including soft tissue injuries, pressure groove injuries, jaw fractures and other comprehensive fractures. Injuries to the oral cavity and maxillofacial area have a small fatality rate, but are extremely destructive to the face and function, and their treatment has become one of the directions that medical care has paid more and more attention to in recent years. Among the many sports injuries, oral and maxillofacial injuries have long received attention due to their high incidence, long treatment time, high treatment costs, and greater psychological impact on athletes, and have been recognized in many countries for a long time. are the most common sports injuries. A survey of 409 athletes showed that the sport with the highest injury rate was wrestling (83.3%), followed by boxing (73.7%), basketball (70.6%) and karate (60%) . Most of these injuries occur in the maxilla, especially the maxillary anterior teeth are the most vulnerable.

1.2 Mechanical analysis of tooth damage

Teeth can maintain firmness, mainly relying on the support of gingiva, cementum, periodontal ligament and alveolar bone. At the same time, due to the point-like contact between the teeth, the teeth are arched to form a dental arch, which increases the overall stability of the teeth. resistance. Under the action of severe external force, the gums, periodontal ligament fibers, and alveolar bone of the tooth are damaged, and the connection between the tooth and the alveolar bone is interrupted and falls off. Healthy teeth can withstand large vertical forces, but have poor tolerance to horizontal forces and rotational forces. These two external forces can cause horizontal displacement of teeth, loosening of teeth, and finally tooth dislocation. Some scholars believe that: the ratio of the tooth's resistance to vertical external force to that of horizontal external force is 62:1. Some people have tested that the vertical force that a tooth can accept is 485.7kg, while the horizontal force can only be tolerated. Tolerate 7.5kg. According to the determination: the world's top level boxer punching power can reach 500kg. Boxing feet can cause displacement or dislocation of teeth.

1.3 Current status of tooth restoration

The oral and maxillofacial area is a prominent and exposed part of the human body, and its trauma is often accompanied by alveolar trauma.If the alveolar bone defect combined with alveolar trauma is not repaired in time, the teeth on both sides will be displaced to the missing side, and the maxillary teeth will be displaced to the opposite side, which will lead to the reduction of the interdental space and the narrowing of the alveolar bone to a certain extent. Low and flat, it is not conducive to the restoration of implant dentures and traditional dentures, and affects the occlusal function and appearance. The traditional treatment method is to first perform debridement and suture for alveolar trauma, arch splint fixation and root extraction, etc., and the denture is restored after the alveolar bone and mucosal damage has healed [3]. However, with the gradual improvement of people's requirements for the quality of life, people pay more attention to the appearance and image, so they also have higher requirements for the aesthetics of teeth when restoring teeth. Dental implants are widely used in dental restorations because of their high aesthetics, comfort, and chewing rate, meeting people's requirements for aesthetics. The basis of dental implant restoration is sufficient alveolar bone volume, but the problem of insufficient dental implant bone volume often occurs in dental implant restoration, which brings difficulties to dental implant restoration. Therefore, the development of ideal artificial bone materials to repair bone defects has become the focus of research in the fields of medicine and biomaterials.

2. Technology and application

2.1 Surface Nanotechnology

With the development of nanomaterials and nanotechnology, surface nanotechnology has become an important direction in the development of surface technology, and it is also one of the important contents of today's nanotechnology.Surface nanotechnology is to prepare some materials into nano-scale powders by modern surface preparation technology and fix them on the surface of objects, so that the materials can obtain new functions and structures, such as high hardness, wear resistance, corrosion resistance, etc. Using nano-surface technology Karksson Met al. formed a nanoporous alumina coating on the surface of titanium alloy implants, and co-cultured with human osteoblasts in vitro. The results were detected by biochemical and morphological methods. Osteocytes showed a normal growth pattern, the number of cells increased continuously, and the phenotype of osteoblasts was normal. Polyacrylamide gel electrophoresis and Western blotting showed that the nanoporous alumina coating could adsorb fibronectin, which was beneficial to bone-implantation. Early healing of the body interface. The long-term stability of implants is not only dependent on osseointegration, but also affected by the healing of soft tissue around the implants. Areva Set al. applied the sol-gel method to form a nano-scale porous titanium dioxide coating on the surface of pure titanium implants and implanted them into the body. After two days of implantation, the adhesion between the coating material and the surrounding soft tissue was observed. The nano-coated implants quickly made contact with connective tissue, while the pure titanium control group formed a fibrocystic encapsulation on the implant surface. This good soft tissue attachment may be due to the titania coating initiating the nucleation and growth of calcium phosphate on the coating surface.

2.2 Nano-artificial bone materials

Nano-scale bone material is a new type of artificially synthesized bone repair material, which has no toxic and side effects, and can be absorbed, degraded and vascularized. The preliminary clinical use of nano-artificial bone shows that it has good biocompatibility with the human body, no immune rejection, and good healing . It is true that sufficient bone mass in the implantation area is the key to the success of oral implantation. Studies have shown that if the bone defect is greater than 1 mm, bone grafting should be sought to facilitate the growth of new bone and the early retention of the implant. nHAC is a new type of nano-hydroxyapatite material independently developed by my country. It imitates the natural bone structure by compounding collagen and hydroxyapatite, and modifies it with polylactic acid, so that the nanostructure is very close to natural bone and has better porosity and biocompatibility. Compared with the previously prepared mineralized collagen composite materials, the mineralized collagen matrix material has more similar characteristics to natural bone tissue in terms of composition and microstructure. Collagen-based nanobone porous framework materials have a three-dimensional pore network structure similar to that of natural cancellous bone, which is beneficial to the transport of nutrients, the migration and growth of cells, and the subsequent formation of new bone tissue after implantation in vivo . Zhu Fei et al. used it to repair mandibular defects in rabbits, and the results confirmed that nHAC has good biocompatibility, and has obvious effects on promoting and accelerating the healing of bone wounds, and the osteogenesis process matches the resorption process of the implant.

3. Conclusion

In a word, in this world where sports are developing and people value self-image, people's attention to teeth is gradually increasing, and clinical medical care also attaches great importance to dental restoration technology and materials used,expect to find more complete methods and more suitable materials. . The birth of nanotechnology and the excellent

properties of nanomaterials that are different from other ordinary materials will determine that it will play an increasingly important role in the study of sports injuries, and provide certain methods for the treatment of sports injuries. practical basis. Nanotechnology in stomatology will also promote the further development of prosthodontics, expanding the indications of prosthodontics, improving the biomechanical properties of prostheses, prolonging the service life of dentures, and improving the success rate of implant restorations. In this regard, it plays an irreplaceable role.

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References

[1] Zhang, HD., Liu, X., Mei, YL., Characteristics of facial injuries and their forensic identification[J].Journal of Law and Medicine,1999(04):153-158.

[2] Yang, YZ., Wang, K., Clinical analysis of 770 cases of maxillofacial injury[J]. Beijing Stomatology, 1994(01):23-26.

[3] Liao, FQ., Zhu, F., Zhang, H., Zhang, LJ., Clinical study of artificial bone and autologous bone in repairing traumatic alveolar bone defect of middle-aged and elderly anterior teeth[J].Chinese Journal of Osteoporosis,2013,19(07):721-724.

[4] COVASSIN T, BEIDLER E, OSTROWSKI J, et al. Psychosocial aspects of rehabilitation in sports [J]. Clinics in sports medicine, 2015, 34(2) : 199 - 212.

[5] BüCHER K, NEUMANN C, HICKEL R, et al. Traumatic dental injuries at a German university clinic 2004 -2008 [J]. Dental traumatology : official publication of International Association for Dental Traumatology, 2013, 29(2) : 127 -133.

[6] Wang, XM., Liu, J., Jia, XF., Gao, XD., Forensic research on the relationship between boxing-induced tooth loss and periodontal disease[J]. Chinese Journal of Forensic Medicine,2003(01): 23-24+26.

[7] Zhang, JQ., Discussion on the mechanics of loose anterior teeth fixation [J]. Journal of Stomatology, 2002(01):62-63.

[8] Wang, SY., Study on the surgical treatment of insufficient bone mass in the implant area[J]. Contemporary Medicine, 2018, 24(32):49-50.

[9] Tao, K., Clinical application of autologous concentrated growth factor combined with Bio-Oss bone meal in implantation with insufficient bone mass in the upper anterior region [J]. Modern Practical Medicine, 2019,31(1):108-111.

[10] Karlsson M, Palsgard E, Wilshaw PR, et al. Initial in vitro interaction of osteoblasts with nano- porousalumina[J]. Biomaterials, 2003, 24 (18): 3039- 3046.

[11] Areva S, Paldan H, Peltola T, et al. Use of sol- gel- derived titania coating for direct soft tissue attachment [J]. J Biomed Mater Res A, 2004, 70 (2): 147, 169, 178.

[12] Zhu, SQ., He, JC., Research progress of artificial bone substitutes in repairing peri-implant bone defects[J].Medical Review,2010,16(06):863-865.

[13] Ettinger RL, Spivey TD, Han DH, et al. Oral Maxillofac implants[J]. Int J, 1993, 8(4): 420.

[14] Liao, SS., Cui, FZ., Zhang, W., Preparation of collagen-based nano-bone composites for tissue engineering. Journal of Chinese Academy of Medical Sciences, 2003, 25(1): 36-38.

[15] Zhu, F., Wang, Y., Wu, YL., et al. Research on repairing rabbit mandibular defects with collagen-based nano-osseointegrated collagen membrane. Journal of Modern Stomatology, 2004, 18(6): 503-506.