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Short Communication

Potential feasibility stem cell transplantation and whole-tooth engineering

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Multipotent mesenchymal stem cells from bone marrow are expected to be a somatic stem cell source for the development of new cell-based therapy in regenerative medicine. However, dental clinicians are unlikely to carry out autologous cell/tissue collection from patients (i.e., marrow aspiration) as a routine procedure in their clinics; hence, the utilization of bone marrow stem cells seems impractical in the dental field. Dental tissues harvested from extracted human teeth are well known to contain highly proliferative and multipotent stem cell compartments and are considered to be an alternative autologous cell source in cell-based medicine. This article provides a short overview of the ongoing studies for the potential application of dental stem cells and suggests the utilization of 2 concepts in future regenerative medicine: (1) dental stem cell-based therapy for hepatic and other systemic diseases and tooth replacement therapy using the bioengineered human whole tooth, called the "test-tube dental implant." Regenerative therapies will bring new insights and benefits to the fields of clinical medicine and dentistry.

Tissue engineering is a multidisciplinary research field involving both science and technology [1, 2]. It is based on principles of biomaterial science, stem cell biology, and genetic engineering [3–5]. Until several years ago, tissue engineering research in the field of dentistry was mainly limited to scaffold materials such as biodegradable polymers and inorganic materials and their combination with signaling molecules such as soluble trophic factors, which induce tissue regeneration [6–10]. In 2006, a new approach to tissue regeneration was revealed with the establishment of mouse induced pluripotent stem (iPS) cells [11]. In 2007, a path toward the future introduction of stem cell-based medicine was created with the momentous establishment of human iPS cells [12, 13]. These innovative cells can be artificially induced to develop into cells required for treatment using cells from the patients themselves. The development of such cells has been eagerly awaited for many years. The time is ripe for the application of stem cells to regenerative medicine using traditional tissue engineering approaches based on a combination of biomaterials and signaling molecules. As truly defined stem cells, iPS cells have shown pluripotency with several characteristics related to self-renewal and differentiation potentials, similar to natural pluripotent embryonic stem (ES) cells [14] derived from fertilized ova, which had represented the key resource in regenerative medicine prior to the appearance of iPS cells. iPS cells are now expected to eliminate bioethical problems facing conventional ES cell research and become beneficial for regenerative therapies using stem cells.

Based on recent advances in stem cell research in dentistry, several types of human mesenchymal stem cell populations have been isolated and characterized from dental tissues of extracted teeth [15, 16]. Certain properties of these stem cells have been compared with those of bone marrow-derived mesenchymal stem cells [17, 18]. With the recent achievements in their isolation and characterization, we believe that stem cells with potential equivalency to that of pluripotent stem cells (i.e., ES/iPS cells) are present in extracted human teeth, which represent waste materials whose potential benefit in routine dental therapeutics is unrecognized. Dental stem (DS) cells, which are derived from postnatal tissue and are classified as mesenchymal stem cells, are considered to possess very little possibility of developing into tumors [19–21], a problem that has hindered the practical development of ES/iPS cells. We believe that DS cells have great clinical advantage over ES/iPS cells as an autologous source.

The present review discusses the current status and future prospects of 2 beneficial approaches of regenerative therapy—stem cell therapy and tooth replacement therapy—that we believe to be touchstones for regenerative medicine from the perspective of cell-based medicine. Such therapies, and our own research strategies, have markedly advanced in recent years. We herein present our beliefs on the future of dental therapy. In recent years, many researchers have isolated stem cells with self-renewal and multipotent capabilities from wisdom teeth and deciduous teeth obtained during dental treatment. Several types of dental mesenchymal stem cells have been isolated and characterized: dental pulp stem cells (DPSCs) [22], stem cells from human exfoliated deciduous teeth [23], periodontal ligament stem cells (PDLSCs) [24], stem cells from apical papilla [25], and dental follicle precursor cells [26]. When cultured in vitro, these human DS cells show the ability of a single cell to generate a colony (clonogenicity) and to differentiate into multiple cell lineages, including osteo/odontogenic, adipogenic, and neurogenic lineages, under chemically defined culture conditions. After transplantation of the stem cells combined with appropriate scaffold materials into immunocompromised mice, the DS cells generate the corresponding hard tissue derived from their origin; dental pulp-derived stem cells produce a dentin/pulp-like structure [22], and periodontal

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ligament (PDL)-derived stem cells produce a cementum/PDL-like structure [24]. Various therapeutic applications of these stem cells have been subsequently assessed in experimental animal models of not only dental disease [24, 25, 27–30], but also systemic disease [31–35].

More recently, a new type of stem cell population, immature dental pulp stem cells (IDPSCs), which are derived from dental pulp of exfoliated deciduous teeth, has been introduced [36]. These unique DS cells, obtained by outgrowth culture of dental pulp tissue fragments, have highly clonogenic and proliferative activities. They express several pluripotent cell markers, including Oct-4 and Nanog, and can differentiate under chemically defined conditions into multiple cell lineages: neurogenic, chondrogenic, osteogenic, and myogenic. Moreover, IDPSCs contributed to mouse embryogenesis when the cells were introduced into mouse developing blastocysts, which developed into human/mouse chimera embryos and fetuses in foster mice (the chimeras were collected from the mothers before birth according to ethical recommendations) [37]. These findings demonstrate that human IDPSCs behave as pluripotent stem cells like ES/iPS cells in vitro and in vivo, suggesting that somatic stem cells that originate from human teeth have great potential as an alternative stem cell population to ES/iPS cells. Various investigations have pointed to the existence of variations within the scheme of the oral fissure among people with congenital anomaly, which may cause physiological alterations within the flow and composition of spit that ar vital within the microbic establishment of tooth surfaces by such species as S. mutans and S. sobrinus, officious directly with the initiation of pathological processes like tooth decay. Based on the info within the literature and thanks to lack of studies on the caries–saliva–microorganism relationship, there's a desire for studies that higher elucidate the ecological characteristics of the oral fissure in patients requiring special care, like those with congenital anomaly, World Health Organization naturally could have special physiological and microbiological characteristics. The identification and determination of the prevalence of pathogens related to the etiology of diseases like tooth decay and its correlation with the clinical secretion parameters of people with congenital anomaly, World Health Organization show physiological peculiarities inherent to the syndrome, is of elementary importance for the understanding of the initiation and development of the disorder and for the determination of higher types of treatment and hindrance. Thus, the aim of this study was to judge the incidence of cavity, the secretion profile, the quantity of mutans streptococci and prevalence of S. mutans and S. sobrinus in people with congenital anomaly.

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