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Significance of Stem Cells in Forensic Dentistry

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Abstract

In forensic point of view and for genetic study, biological samples collected at a crime scene serve as a significant tool, in order to resolve crimes by identifying the person. In some scenarios, individual identification gets masked by chimera persons, where the chimera person cells will have different DNA. The use of biological traces which are recorded by a person's touch while handling items raises the chance of forensic study system. Therefore, DNA profiling can be obtained from items that were touched, which inturn becomes an useful means for forensic mode of investigation. Chimerism investigations are recognized processes to examine the condition of Hematopoietic Stem Cell Transplantation (HSCT) to analyze peripheral blood and recipient's bone marrow samples for non-malignant and malignant hematologic diseases. In adults, ectomesenchymal cells identified in oral and maxillofacial tissues are promising for future dental stem cell therapies, because the oral tissues area rich source for stem cells. Dental stem cells have various expressive profiles and exist in specific niches. Apart from these applications, this review article highlights dental stem cells significances in forensic dental investigations.

Keywords: Chimerism, Forensic, Hematopoietic, Stem Cell

Introduction

Forensic science deals with the personal identity process by using comparative methods or by identifying the profile of the individual by gender determination and also their age at death, for investigations using biological evidences obtained from a crime, such as murder, sexual assault and also during a disaster. The obtained biological specimens from the crime scene provide remarkable information regarding the crime and the person involved[1,2].

Stem Cells in Oro-facial Region

Dental structures are comparatively more resistant to the higher temperatures and also established that progenitor stem cells dwell within the oro-facial regions. The stem cells exist in the oro-facial region were classified as adult stem cells, mesenchymal stem cells and tissue stem cells[3]. Studies in the stem cells of dental pulp, recognized multipotent mesenchymal type of progenitor cells in several niches and it has a high potential for proliferation in turn promotes auto renewal. The progenitor types of stem cells are identified, as it is a factor for the process of dentin regeneration, subsequent to an injury. The stem cells harvest from the deciduous teeth is a source for tissue regeneration and repair[4]. Dental tissues have five types of stem cells; they are dental follicle, apical papilla, dental pulp and periodontal ligament[5]. Saliva is a useful DNA resource because it is being collected through painless, non-invasive manner, which can be able to use even if it is stored in the various conditions.

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DNA

Deoxyribonucleic Acid (DNA) technology gained its recognition in crime investigative processes involving biological evidences. The DNA markers are permissible for greater precision and it has higher powers in discriminating the factors in forensic testing. The DNA techniques in Forensic Dentistry is being a promising tool where traditional methods fail to identify, due to the heat, trauma or in autolytic process, leads to distortions results in difficulties in analysis[5]. Genomic DNA found in each cell nucleus represent the DNA source for the many forensic applications. Though the body tissues are decomposed, the structures of enamel, dentin and pulp may exist. It is essential to extract the DNA from the calcified tissues, so the teeth represent as a source of genomic DNA. Moreover, the authors found, even a root-filled tooth can have sufficient biological materials for Polymerase Chain Reaction (PCR) analysis[6].

Polymerase Chain Reaction

The teeth present as a rich source of DNA for easy person identification. In forensic cases, due to the great quantity of biological material, the PCR technique acquired its significance in DNA post mortem analysis. PCR is for an enzymatic amplification of a more specific DNA sequence, by the way it's aiming the millions of its copies and production from this type of sequence in a test-tube and it is first described in late 1980 by Kary Mullis. This enables a latest strategy for genetic analysis through a simple and fastest method by excusing all difficult stages in genetic cloning[5]. PCR enables the dissimilarity of a person among the others with a high intensity of reliability, which starting by 1 nanogram, it is equivalent to a one part in a billion grams, in the DNA target[7]. However, these molecular methods were relatively new and in need to be evaluated from different methods for identification, which can be applicable in forensic dentistry are readily available. However, everything has its own limits, so this should be in mind while using such techniques. It is necessary to widen the relevant studies of this theme in order to obtain protocols to use additional tools in crime investigations.

Chimerism

In forensic science, biological traces are utilized to solve cases by typing their genetic profile and thereby identifying the person whom it belong. Chimeric individuals own cells will have two or more dissimilar DNA, leading the types of analyses complex. Chimerism can arise naturally, by an error during fertilization or in early embryogenesis, otherwise in an artificial method, for instance it can happen after hematopoietic stem cell transplantation, in a scenario where host and donor cells exist in that individual. The traces from the transplant patients represent a task in forensic perspective from the analysis of genetic fingerprint which will mislead because of chimerism. Over years transplant patients are increasing and in the existing natural chimeras, mostly many of them are hidden, so it is necessary to judge that whether we face a probable chimeric person or the person is someone whom we consider as a donor for hematopoietic stem cells in forensic perspective. Therefore, to accentuate the significance of chimerism after hematopoietic stem cell transplantation in the forensic genetics, real-life cases are examined to substantiate the misleading factor due to chimerism. Still, chimeric persons who have more than single chromosomal population will be a challenge for forensic analysts[9,10]. The genetic profile sampled from blood, skin swabs and buccal swabs are matched with their sibling allogeneic type of hematopoietic stem cell transplantation succeeded without any signs of skin graft versus host disease[11].

STR-PCR

To evaluate chimerism status, autosomal Short Tandem Repeat (STR) genotyping is performed by means of the gender marker Amelogenin. According to this analysis report, donor chimerism will be detected in recipient's blood samples. Hence, chimerism status analysis considered as a well established process to monitor the state of HSCT in course of time to analyze peripheral blood samples or bone marrow recipient's samples in many non-malignant and malignant hematologic diseases. STR analysis process is through simple Polymerase chain reaction (STR-PCR) together with capillary electrophoresis and it is the most

potent method in which high power of differentiation guaranteed between different persons. Other methods are developed to defeat the technical limits of Short Tandem Repeat-Polymerase Chain Reaction. Other methods are real-time qPCR-quantitative Polymerase Chain Reaction, dPCR-digital Polymerase Chain Reaction, NGS-next-generation sequencing technology. After a relative evaluation of variety of molecular biology techniques, STR-PCR remains the gold standard choice and widely accepted method for chimerism analysis[12–15].

Saliva traces can be collected from drinking receptacles, cigarette butts, etc like that in crime scenes, which serves as a largest source of DNA. Epithelial cells collected from oral mucosa from bone marrow transplantation patients shown mixed chimerism[16–19]. The recipient/donor DNA ratio sampled from buccal swabs was highly inconsistent between individuals[18,20]. The epithelial cells from buccal swab are contaminated during the process of collecting swabs with saliva, which may contain leukocytes from the human mucosa. The epithelial cells are derived from donor after receiving the successful transplantation. Approximately 79% of samples from buccal swabs have a mixed profile of the both donor and recipient; remaining 21% of the samples remain donor free[21].

In 2003, Tran *et al.*[22] demonstrated that how stem cells were derived from the bone marrow and possibly hematopoietic stem cells have migrated from marrow to cheek, while some differentiating into the epithelial cells[22]. To monitor chimerism, samples collected from buccal mucosa through a traditional swab method, is used to attain the reference profile if there are no recipients samples that had been taken before hematopoietic stem cell transplantation. In spite of mixed profile in the saliva samples, since donor type be usually known or it can be established using a blood sample, so it is usually easy to divide donor and recipient profiles for a clinical purpose. Though buccal swabs are very significant in chimerism, the amount of donor cells is negligible if it is taken after rinsing the mouth several times, even in full donor chimerism persons.

Conclusion

This review represents the current knowledge of forensic expert in identifying a person with the available molecular biology techniques which are used for analysis of chimerism using dental tissue. Chimerism analysis is not only investigated in the Medical field for therapy, it is also investigated in the field of forensic dentistry for person identification, as well opening newer insights and avenues for research in this hitherto less ventured arena of Forensic dental investigations using stem cells.

Future Directions

There is no unanimity of opinion concerning the usefulness of dental pulp and jaw bone marrow in forensic science. Although, there will be physical barrier and some limitations in the integrity. Further systematic studies with DNA extract from pulp and bone marrow from jaw bones are required for routine analysis of chimerism by available molecular techniques used by forensic experts.

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Nil.

Conflict of Interest
No.

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