THE ROLE OF STEM CELL THERAPY IN OTOLARYNGOLOGY

Essay submitted for fulfillment of Master Degree in Otorhinolaryngology

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For any errors or inadequacies that may remain in this work, of course, the responsibility is entirely my own.

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CONTENTS

LIST OF ABBREVIATIONS

AN	Auditory nerve
ANs	Auditory neurons
CNS	Central nervous system
DP	differentiated progeny
ENT	Ear, Nose, Throat
HO	Hearing organ
IVF	In vitro fertilization
MSC	Mesenchymal stem cells
RC	Rosenthal's canal
Sa	Stapedial artery
SC	Stem cell
SG	Spiral ganglion.
SM	Scala media
Sp. L	Spiral ligament
ST	Scala tympani.
SV	Scala vestibuli.
WHO	World Health Organization.

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INTRODUCTION

Artificial transplantation or transplanted organs is a successful therapy for otherwise incurable end-stage diseases or tissue loss. However, such interventions are challenged by organ shortage, the necessity of lifelong immunosuppression and its potential for serious complications. Tissue engineering has emerged as a rapidly expanding approach to address these problems and is a major component of regenerative medicine. Tissue engineering is an interdisciplinary field that applies the principles and methods of bioengineering, material science, and life sciences toward the assembly of biologic substitutes that will restore, maintain, and improve tissue functions following damage either by disease or traumatic processes. ***(Shieh and Vacanti, 2005).***

Efforts are now being undertaken for engineering a variety of tissue and organ types with an emphasis on the application of stem cells. Ultimately, the goal of tissue engineering is to regenerate tissues and restore organ function through cell implantation and matrix incorporation into the patient. ***(Fuchs et al, 2001).***

A number of criteria must be satisfied in order to achieve effective, long-lasting repair of damaged tissues. 1) An adequate number of cells must be produced to fill the defect. 2) Cells must be able to differentiate into desired phenotypes. 3) Cells must adopt appropriate three-dimensional structural support/scaffold and produce extracellular matrix. 4) Produced cells must be structurally and mechanically compliant with the native cell. 5) Cells must successfully be able to integrate with native cells and overcome the risk of immunological rejection. 6) There should be minimal associated biological risks. ***(Vats et al, 2002).***

The source of cells utilized in tissue engineering can be autologous (from the patient), allogenic (from a human donor but not immunologically identical), or xenogenic (from a different species donor). ***(Naughton, 2002).***

Autologous cells represent an excellent source for use in tissue engineering because of the low association with immune complications. Autologous cells are however not cost effective and batch controlled for universal clinical use. In contrast, allogenic cells offer advantages over autologous cells in terms of uniformity, standardization of procedure, quality control and cost effectiveness. ***(Knight and Evans, 2004).***

The field of tissue engineering has significant potential for developing viable, natural tissue constructs. The primary basis for any tissue-engineered construct is the cellular source that is used to initiate new tissue growth. The investigations of strategies that incorporate stem cells, however, have shown promising results for engineering soft tissue. The use of stem cells for tissue-engineering applications is still met with ethical concerns and scientific obstacles that must be addressed. ***(Gomillion and Burg, 2006).***

Rapid advances are being made in stem cell research with a focus on their therapeutic potential for regenerative medicine and other biomedical applications. In combination with tissue engineering, stem cells hold a number of promises in further advancing contemporary medicine. Although much progress has been made in the field of tissue engineering, further work toward organ and tissue replacement is necessary. The optimal cell source, scaffold design, and in vitro bioreactors, the use and development of microfabrication technology to create vascularized tissues and organs are still being investigated. The search for and use of an appropriate multipotent or pluripotent stem cell in tissue engineering is an emerging concept. Certainly, many areas of stem cell research and their potential clinical applications are associated with controversies; therefore, it is important to address the ethical, legal, and social issues early. Many technical questions are yet to be answered and require close interdisciplinary collaborations of surgeons, engineers, chemists, and biologists, with the ultimate goal of functional tissue restoration. As more scientific knowledge will be gained from stem cell research, hopefully, some of the current ethical and technical concerns will be answered or removed in the future. ***(Kim and Evans, 2005).***

Aim of the Work

To give an idea about the stem cells in terms of its sources, fates, characteristics, advantages, limitations and applications in general and in Otorhinolaryngology – Head & Neck surgery.

STEM CELLS

STEM CELLS

Introduction

Stem cell biology is now one of the most exciting and rapidly advancing areas of scientific effort. Promises of cures of a wide variety of diseases by specific replacement of damaged or malfunctioned tissues by use of totipotent or multipotent stem cells are on the horizon in clinical practice. Stem cells derived from the embryo and from adult tissues have been shown to have extensive potentials for self-renewal and differentiation. ***(James, 2002).***

Different cell types that could be used for repair and regeneration include mature cells obtained from the patient or stem cells (either adult or embryonic).
The use of mature cells obtained from the patient minimizes the need for immunosuppressive therapy after implantation, but these cells may not be the best source of cells for tissue regeneration, primarily because these adult cells have already differentiated and committed to a specific cell type. This option provides little potential for further growth and limits the source of harvested tissue for repair to the site of the initial damage. ***(Vats et al, 2002).***

Definition & Characteristics

Stem cells, on the other hand, are by definition a population of cells able to provide replacement cells for a specific differentiated cell type. ***(Ballas, 2002).***

Stem cells have the ability to build every tissue in the human body; hence, they have great potential for future therapeutic uses in tissue regeneration and repair. ***(Jesse and Brenda, 2009).***

These unique cells are different from other cell types in three defined respects. First, stem cells are able to divide and renew themselves over long periods of time, ***(Conrad and Huss, 2005)*** and are able to replicate or proliferate several times. By virtue of their ability to self-replicate, stem cells are said to be self-renewing. ***(Zandstra and Nagy, 2001).***

Secondly, stem cells are not specialized and they are immature, meaning that they do not have any tissue specificity and are not required to perform specialized, tissue-specific functions. Third, stem cells differentiate into specialized cells. ***(Conrad and Huss, 2005).***

The general designation stem cell encompasses many distinct cell types. Commonly, the modifiers embryonic and adult are used to distinguish stem cells according to the developmental stage of the animal from which they come, but these terms are becoming insufficient as new research has discovered how to turn fully differentiated adult cells back into embryonic stem cells, and conversely, adult stem cells, more correctly termed somatic stem cells meaning ''from the body,'' are found in the fetus, placenta, umbilical cord blood, and infants. ***(Bajada et al, 2008).***

Stem cells are capable of differentiating into at least one type of specific cell. How potent a stem cell is, or how many different cell phenotypes it can