Role of Stem cells in the treatment of Sensorineural hearing loss

Essay

Submitted for Partial Fulfillment of Master Degree
In Otolaryngology and Head&Neck surgery

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2012

Introduction

Sensorineural hearing loss (SNHL) is a type of hearing loss caused by irreversible loss of inner hair cells which may lead to loss of spiral ganglion neurons (SGNs) or is caused by damage to the inner ear nerves (vestibulocochlear nerve) or central processing centers of the brain ***(Haynes, 2009).*** SNHL can be present at birth (congenital), or may develop in children or adults later, sudden or slowly progressive in life (acquired). SNHL includes two types Sensory hearing loss and Neural hearing loss ***(Ceylan, 2007).***

SNHL is the most common sensory disorder in humans and it accounts for about 90% of all hearing loss and it is found in 23% of population older than 65 years of age ***(Margolis, 2008).*** In Egypt, the prevalence of SNHL in the Egyptian elderly (>65 years) is reported to be 44.3% ***(Abdel-Hamid et al., 2007).***

As the hair cells (HCs) or the sensory neurons donot have the potential to regenerate in the mammalian cochlea. So,the treatment of the SNHL constitutes one of the greatest challenges in the treatment of inner ear disease ***(Raphael, 2002).***

Treatment of SNHL has many methods includes the cochlear implantation, the auditory brainstem implant (ABI)

and cellular replacement. The cochlear implant directly stimulate the auditory nerve, bypassing damaged portions of the inner ear but postimplantation rehabilitation ,the high costs of the operation and prosthesis have a heavy influence in their accessibility ***(Spahr et al., 2004).***

Auditory brainstem implant (ABI) is similar to cochlear implant but it stimulats the cochlear nucleus (CN).This requires an electrode implanted directly into the brainstem, making this device more risky and still not widely used ***(Moore et al., 2009).***

Cellular replacement is a promising therapeutic strategy as cell substitution therapy by replacement or restoration of damaged HCs and/or SGNs has the potential to have a highly significant impact on human health over the next few decades ***(Rivolta et al., 2010).***

Stem cells (SC) are excellent candidates for biological implantation as they have the potential to proliferate and differentiate, both required features for a regenerative strategy option ***(Naito et al., 2004).***

There are four main SC sources for regeneration of ciliary cells which are: Stem cells isolated from the internal ear itself, embryonic stem cells, neural stem cells and mesenchyme stem cells of bone marrow. The Stem cells which are isolated from the internal ear itself as the utricular epithelium of adult

mammals contain support cells with progenitor properties. Many researches were done on these cells in mammals (adult rat, chicken embryo), it was found that these cells when implanted in other organs(developing ears, muscles and liver of chicken embryo) were capable of proliferation, were totally incorporated suggesting multipotent features of such stem cells ***(Li et al., 2003).***

Embryonic Stem Cells which are originated from a cell group from inside the blastocyst, when implanted in deaf laboratory animals result in floating of cells in the perilymph and its adherence in the cochlear cytoarchitecture ***(Coleman et al., 2006).***

Neural SC are able to differentiate in the main kinds of neural cells: neurons, astrocyte and oligodendrocyte, when implanted in the internal ear of adult laboratory animals it survived for at least 4 weeks after the implantation and migrated to functionally important regions: Corti organ, spiral ganglion and auditory nerve ***(Hu et al., 2005)***

Mesenchyme SC of bone marrow is able to differentiate into several cell kinds (osteoblasts, chondrocyte, myoblasts, adipocyte and neurons) and are easily obtained. After implanting autologous cells of bone marrow in internal ear of rats carrying induced deafness, demonstrated survival and migration of injected cells in several cochlea regions: vestibular

and tympanic scales, spiral ligament, strias vascularis and modiolo, including spiral ganglion and cochlear nerve ***(Naito et al., 2004).***

Finally, it is possible that treatments based on the transplant of stem cells may be applied to the damaged inner ear as part of future clinical applications in the treatment of SNHLas the experimental use of stem cells to treat SNHL shows promising results for further clinical application.

Aim of the Work

The aim of this review is to highlight the role of using stem cells in the treatment of SNHL to give us a solid background to carry out an applied research in this field.

Acknowledgment

I am deeply grateful for the support and constructive guidance of many people, whose valuable assistance made this study possible.

First and foremost I would like to express my thands and deep appreciation to ***Prof. Mohamed Magdy Samir****, Professor of otolaryngology and Head & Neck Surgery, Faculty of Medicine-Ain Shams University for encouraging me to develop this subject, and for all inspiring guidance, valuable supervision and help he has given me since I started the research.*

I am eternally grateful to ***Asst. Prof. Mohamed Amir Hassan,*** *Assistant Professor of otolaryngology and Head & Neck Surgery, Faculty of Medicine-Ain Shams University for his help and keep support, without his help this work would have never been completed. I am deeply indebted to for his scrutiny, his comments and suggestion and his deep interest in the subject.*

I wish to express my great and ultimate thanks to all my professors and colleagues for their encouragement, help and supporte.

Dedicated to my family and my wife and my children Steven and Celina for their

Love,

Support,

Patience

And

Understanding

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List of Abbreviation

3NP : 3-nitropropionic acid
ABR : Auditory brainstem response.
AD : Alzheimer's disease.
AIDS : Acquired immunodeficiency syndrome.
ALS : Amyotrophic lateral sclerosis.
AP : Action potential.
BDNF : Brain-derived neurotrophic factor
bFGF : Basic fibroblast growth factor
BM : Basilar Membrane
BMP4 : Bone morphogenetic protein 4
BMT : Bone marrow transplantation.
CBR : Cord Blood Registry
CES : Chronic electrical stimulation
CLW : Cochlear lateral wall
CM : Cochlear microphonic.
CN : Cranial nerve.
CN : Cranial nerve.
CNS : Central nervous system.
CPCs : Circulating progenitor cells.
CT : Computed tomography.
DPOAE : Distortion product otoacoustic emission.
DRG : Dorsal root ganglion neurons
EBs : Embryoid bodies
EC : Embryonic carcinoma.
EGF : Epidermal growth factor
EIM : Embryonic inner mass.
EPCs : Endothelial progenitor cells.
ESCs : Embryonic stem cells.
EYFP : Enhanced yellow fluorescent protein
FDA : Food and Drug Administration
FGF : Fibroblast growth factor
GDNF : Glial derived neurotrophic factor
HCs : Hair cells

hEGCs : Human embryonic germ cells
hESC : Human embryonic stem cells.
hFASCs : Human foetal auditory stem

HI : Hearing Impairment.
HSC : Hematopoietic stem cell.
IAM : Internal auditory meatus
ICM : Inner cell mass.
ICP : Intracranial pressure.
IGF1 : Insulin-like growth factor 1
IHCs : Inner hair cells
iPSCs : Induced pluripotent stem cells
IRBSNHL : Idiopathic progressive bilateral SNHL
ITSS : Insulin-transferrin-sodium selenite
LIF : Leukemia inhibitory factor.
LOC : Lateral olivocochlear.
LSCC : Lateral semicircular canal
LSO : Lateral superior olive.
LVEF : Left ventricular ejection fraction.
MEFs : Mouse embryonic fibroblasts
mESC : Mouse embryonic stem cells.
MOC : Medial olivocochlear.
MRI : Magnetic resonance imaging.
MSCs : Mesenchymal stem cells
MSO : Medial superior olive.
NGF : Neurotrophic growth factor
NSAIDS : Nonsteroidal anti-inflammatory drugs.
NSCs : Neural stem cells.
NT3 : Neurotrophin-3
OHCs : Outer hair cells
OSCFM : Otic stem cell full media
PD : Parkinson's disease.
RA : Retinoic acid
RSC : Retinal stem cell.
SAA : Severe aplastic anemia.
SCID : Severe combined immune deficiency.
SDIA : Stromal-derived inducing activity
SGNs : Spiral ganglion neurons
SMBs : Skeletal myoblasts.
SNHL : Sensorineural hearing loss.
SOC : Superior olivary complex.
SP : Summating potential .
SSNHL : Sudden sensorineural hearing loss.
SVZ : Subventricular zone.
TM : Tectorial Membrane .
TOAE : Transient-evoked otoacoustic emission.

Tuj 1	: Neuron-specific class III beta-tubulin
UCBC	: Umbilical cord blood cells.
VCN	: Ventral cochlear nucleus
VDRL	: Venereal Disease Research Laboratory.
VGLUT	: Vesicular glutamate transporter
WHO	: World Health Organization.
Y-FISH	: Ychromosome fluorescence in situ hybridization

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Recommendations

The advances in stem cell technologies are offering a glimmer of hope for millions of people affected with deafness. Although still at a very early stage, a growing bulk of literature is being produced attempting to pave the path for a stem cell-based therapy for deafness and there are many obstacles must be overcome.

1- Specific protocols must be developed to enhance production survival, and integration of transplanted cells.

2- More human pluripotent and multipotent cell research is needed since stem cell biology differs in mice and men.

3- Finally, clinical trials must be completed to ensure safety and efficacy of the stem cell therapy.