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Published by : Dr. Shahiqul Jabbar
Associate Professor & Head
Department of Orthodontics and Dentofacial Orthopedics
Chattagram Internal Dental College
206/1, Haji Chand Meah Road, Shamserpara, Chandgaon
Chattogram, Bangladesh.
Cell : 01753 20 03 23, Phone : (031) 2573119-23
E-mail : shahiqu_ipni@yahoo.com, www.cidch.edu.bd

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Cell : 01819 80 30 50

Chattagram International Dental College
206/1, Haji Chand Meah Road, Shamserpara, Chandgaon, Chattogram, Bangladesh.
Cell : 01753200323, Phone : (031) 2573119-23, E-mail : info.cidchbd@gmail.com
Website : www.cidch.edu.bd

Information to Authors

Chattagram International Dental College (CIDC) started its historical and memorable journey in the 2003 year. CIDC is the only Private Dental College in Chattogram which is smoothly running under the guidance of Chittagong University.

CIDC is approved by the Government of the Peoples Republic of Bangladesh and is recognised by the Bangladesh Medical and Dental Council (BMDC). CIDC is representing pioneer and exemplary academic and clinical oriented research institute of Bangladesh. About 65 Dental students completed their graduation from CIDC per annum.

Chattagram International Dental College commenced to publish a peer reviewed Journal from 1st January 2018. The journal intend to publish article of authors from any part of the globe, but has a special interest in publishing research articles of authors from Bangladesh and of relevance to developing countries. It interested in Editorial, Original (Research) articles, Special articles, Review articles, Short Communications, Case report and letters on new findings of Medical Science.

Chattagram International Dental College Journal is published in english, biannually eg. January and July with prior approval of Editorial board.

Appropriate measures has been taken to make the journal indexed / abstracted in major international indexing systems including the PubMed/MEDLINE, Index Medicus, Google Scholar, DOAJ, Hinari and Scopus etc. The theme of Journal of Chattagram International Dental College is

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References

Regarding references please follow the Vancouver style (Uniform requirements for manuscripts submitted to biomedical journals prepared by the International Committee of Medical Journal Editors (ICMJE guideline http://www.icmje.org).

Reference citations in the text should be numbered in arabic numerals at the end of the sentence eg [1,2] consecutively in order in which they are mentioned in the text.

Book references should have the name of the authors, chapter title, editors, Book name, the edition, place of publication, the publisher, the year and the relevant pages.

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The first six authors of a work should be named, followed by 'et al' if there are more than six. If less than six authors the name of the all authors may be mentioned.-

Examples

Book reference : Stoll BJ, Shane AL. Infections of the neonatal infants in RM Kliegman, BF Stanton, JWS Geme, NF Schor. Nelson text book of pediatrics. 20th edn. Elsevier. Philadelphia. 2016;1:909-925.

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Table

- All tables should be numbered using Roman numerals (I, II).
- Table should always be cited in text in consecutively using Roman numericals (eg Table I, II).
- Mentioned the caption at the top of table. Table should be planned as brief as possible.
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Department of Orthodontics and Dentofacial Orthopedics
Chattagram International Dental College
206/1, Haji Chand Meah Road, Shamserpara,
Chandgaon, Chattogram, Bangladesh.
Cell : 01753200323, Phone : (031) 2573119-23
E-mail : shahiqu_ipni@yahoo.com
Website : www.cidch.edu.bd

Competing Interests

Chattagram International Dental College Journal requires authors to declare any competing financial or other interest in relation to their work. Where an author gives no competing interests, the listing will read the author (s) declare that they have no competing interests.

Editorial

Chattagram International Dental College Journal

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Rational Use of Antibotics

Shahiqul Jabbar[1*]

The earth is surrounded by beautiful trees, river and mountain but it also harboring multiple harmful microbes that affect the life of her inhabitants. For the past 80 years, antibiotic therapy has been playing a major role in the treatment of bacterial infectious disease. Since the discovery of penicillin in 1928 by Sir Alexander Fleming & sulfanilamide in 1935 by Gerhard Domagk, the entire world has benefited from one of the greatest medical advancement in history. According to the Centers for Disease Control & Prevention, life expectancy of individuals in the United States born in 1900 was 47 years, while those born in 2005 is projected to be 78 years[1]. At the beginning of the 20th Century, the infant (<1 yrs) mortality rate in the US was 100/1000 live birth compared to 6.7/1,000 in 2006[2]. The major reason for these phenomenal achievements might be the charisma of antibiotics[3].Unfortunately, there have also been an explosion in the number of bacteria that has become resistant to a variety of these drugs. The problem is not the antibiotic themselves. Instead, the problem is in the way of the drug using. The inappropriate overuse of antibiotics has resulted in a crisis situation due to bacterial mutations developing resistant strains[4].

The proper clinical use of Antibacterial Drugs- In 1997, the ADA Council on Scientific Affairs issued a positioned statement on Antibiotic use in Dentistry[5]. The council stated: “Microbial resistance to antibiotics is increasing at an alarming rate. The major cause of this public health problem is the use of antibiotics in an inappropriate manner leading to the selection of dominance of resistant micro-organism and/or the increased transfer of antibiotic resistance genes from antibiotic resistant to antibiotic susceptible micro-organism[5].”

The Council’s position statement further identified that “Antibiotic are properly prescribed only for the management of active infectious disease or the prevention of distant infection, such as infective endocarditis, in medically high-risk patients.

There is a Glimmer of Hope

A report from Aker University in Oslo, Norway, strongly suggests that bacterial resistance to antibacterial agents can be reversed[6]. While dangerous and contagious staph infections kill thousands of patients in the most sophisticated hospital in Europe, North America & Asia, there is virtually no sign of this “killer superbug” in Norway. The reason? Norway has stopped taking so many antibiotics. In Norways' simple solution, there is a glimmer of hope.

A unanimously changed view of antibiotic is needed. All antibiotic use, appropriate or not “uses up” some of the effectiveness of that antibiotic, diminishing our ability to use it in the future. For current & future generation to have access to effective prevention & treatment of bacterial infection as part of their right to “health for all”. The window of opportunity is rapidly closing[7].

Let us come forward to safe our planet for living against the invaders and keep the natural longevity of each individuals uninterrupted by formulating a common action plan globally about “Rational use of Antibiotics”.

Disclosure

The author declared no competing interest.

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2. Health United States. US Department of Health & Human service, centers for disease control & Prevention, National center for Health statistics. 2010.

1. Associate Professor of Orthodontics and Dentofacil Orthopedics
Chattagram International Dental College
Chattogram.

*Correspondence to :
Dr. Shahiqul Jabbar
Cell : 01753 20 03 23
Email : shahiqu_ipni@yahoo.com

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Original Article

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Mandibular Cortical Shape Can Be An Indicator of Possible Osteoporosis of Postmenopausal Woman

Md. Abu Saeed Ibn Harun[1*] Mahabubul Islam Mazumder[2] A K M Shalauddin[3]

Abstract

Background: *The consequences of aging often involve the risk of osteoporosis, leading to an impaired quality of life of the elderly patient. The aim of this study was to see the mandibular cortical bone in postmenopausal osteoporotic patient with and without treatment.* ***Materials and methods:*** *150 postmenopausal osteoporotic patients were divided into two groups under the condition of treated and non treated. All patient were evaluated by Dual Energy X-ray Absorptiometry (DEXA) Orthopantomograph (OPG) and Radiovesiograph (RVG).* ***Results*** *:The result of this studyshowed that 83% and 84% of mandibular cortical index were eroded (C_2 & C_3) in osteoporosis and treated osteoporosis respectively.* ***Conclusion:*** *There are significant relationships of osteoporosis treatment with alveolar bone. Most of osteoporosis patient had eroded mandibular cortex.*

Key words

Mandibular cortex; Osteoporosis; Postmenupausal; Dual Energy X-ray Absorptiometry (DEXA); Orthopantomograph (OPG); Radiovesiograph (RVG); C_2; C_3.

Introduction

Osteoporosis is a medical disorder characterized by a generalized low bone mass and fragility with a consequent increase in fracture risk, particularly of vertebrae, hip and wrist[1]. There are two types of osteoporosis: i) Postmenopausal osteoporosis caused by cessation of estrogen production and characterized by spinal fracture ii) Osteoporosis that affect the older population and results in proximal femur fracture[2]. Charles Dent said that “senile osteoporosis is a pediatric disease,” meaning that failure to achieve adequate peak bone mass during adolescence increase the risk of osteoporosis in later life[3].

1. Associate Professor of Conservative Dentistry and Dental Radiology
Chattagram International Dental College
Chattogram.
2. Professor of Medicine
Comilla Medical College
Kumilla.
3. Associate Professor of Prosthodontics
Chattagram International Dental College
Chattogram.

*Correspondence to :
Dr. Md. Abu Saeed Ibn Harun
Cell: 01711 15 75 86
Email : drharunpg@yahoo.com

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Alveolar bone is a unique tissue representing the most viable part of the tooth-supporting apparatus. The alveolar process consists of an external plate of cortical bone, the inner socket of thick compact bone and cancellous trabeculae interposed. Alveolar bone is intra membranous in originand undergoes continuous remodeling by osteoblast and osteoclast activity[4,5]. Loss of alveolar bone (Metabolic disease/ osteoporosis/ aging/ periods of inactivity) is always accompanied by loss of periodontal fibers. Periodontal disease is among one of oral problems that most extensively affect human population, being one of the major causes for adult tooth loss[6].

Currently, osteoporosis diagnosis and staging are based on the identification of different risk factors, the most important being low Bone Mineral Density (BMD) of the femoral neck or lumber spine[7,8]. World Health Organization (WHO) has been an established the diagnostic level of bone mineral density less than -2.5 for defined osteoporosis[9].

Suggestion has been made that panoramic radiograph that show progressive periodontal disease, alveolar bone, tooth loss and endosteal resorption of the Mandibuler Inferior Cortex (MIC) may indicate general osteoporosis[4,10]. The uses of panoramic radiographs are common in dental setting. Morphology and functional oral sequel of aging are well documented in dental literature, but not those resulting from osteoporosis[11-15]. Many studies have cited the possible correlation between age, systemic osteoporosis, periodontal disease, tooth loss and changes in quantity and quality of bone of the maxillae and mandible[16-19].

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The restoration of occlusion for partially and totally edentulous patient often requires adequate bone therapy. Consequently, the frequent use of an implant supported prosthesis for the elderly patient who is routinely or potentially osteoporotic demand a better understanding of the relationship between osteoporosis, the stomatognatic system. The aim of this study was to see the mandibular bone changes in postmenopausal osteoporotic condition.

Materials and methods

Total 150 postmenopausal osteoporotic patients were selected for study. 100 patients were freshly diagnosed as osteoporotic condition named group A. Rest 50 patient were treated osteoporotic condition named group B. All treated osteoporosis patient had been taken Aclasta (Zoledronic) in intravenous rout for treatment before 1 year. Patients with suspected condition affected bone mineralization were excluded from this study. All procedure were followed for both groups.

Osteoporosis diagnosis

Osteoporosis was diagnosed by DEXA scans from Comilla Medical College, Comilla. BMD at the lumbar spine and femoral neck were measured by Dual Energy X-ray Absorptiometry (DEXA) scanner.

Panoramic radiographic

All Panoramic radiographs were obtained at the time of the DEXA scan from Central Medical College and Hospital, Comilla. Some visual point were seen in panoramic radiograph there are as follows.

Direction of bone resorption

If bone loss is suggested on the films, it may be 'horizontal' or 'vertical' in character. Horizontal bone loss is indicated when the bone loss interproximally on two adjacent tooth, vertical bone loss is indicated when the bone crest is more apical to the Cemento Enamel Juntion (CEJ) adjacent to one tooth than to other.

Mandibular Cortical Index (MCI)

Panoramic radiograph has been analyzed for mandibular cortical index. According to klemitti et al "MCI is classification of appearance of the mandibular inferior cortex distal to the mental foramen, which includes the following criteria. C_1: The endosteal margin of the cortex is even sharp on both sides of the mandibule. C_2: The endosteal margin has semilunar defects (Resorptive cavities) with cortical residues one to three layers thick on one or both sides.C_3: The endosteal margin consists of thick cortical residues and is clearly porous.

Statistical analysis

Calculation of mean and standard deviation as well as correlation and difference were performed using SPSS 11.5. A p-value less than 0.05 were considered statistically significant.

Results

The mean age of an osteoporotic patient and treated osteoporotic patient were statistically non-significant (Table-I). The lumbar spine and femoral neck BMD were 0.695±0.11 and 0.714±0.13, 0.743±0.15 and 0.694±0.11 respectively in osteoporotic patient (Group A) treated osteoporotic patient (Group B). Those are statistically non-significant.

Changes of mandibular cortical bone has been shown in table II. Mandibular cortical bone has been changed into C_3 type about 60% and 72% of patients in group A and group B respectively. 23% patients in group A and 12% patients in group B has been shown type C_2 mandibular cortical changes. Only 17% and 16% of patients in group A and group B has no changed in mandibular cortical bone (Table II).

Table I : Age, Lumber spine and femoral neck BMD.

	Group A (Osteoporotic patient)	Group B (Treated osteoporotic patient)	p-value (p=0.05)
Age	60.1±9.58	63.1±11.44	p=0.158
Lumber BMD	0.695±0.11	0.743±0.15	p=0.07
Femoral BMD	0.714±0.13	0.694±0.11	p=0.4

Table II : Changes of mandibular cortical bone.

	C_1 (%)	C_2 (%)	C_3 (%)
Group A (Osteoporotic patient)	17	23	60
Group B (Treated osteoporotic patient)	16	12	72

Discussion

In this study, we found that the mean lumbar and femoral BMD of an osteoporotic patient and treated osteoporotic patient was non-significantly different. Cortical width and porosity on dental panoramic radiograph have been shown to be potentially useful assessment method[20]. The age related distribution of MCI showed age related increase in the numbers of individuals with C_3 cortex appearance and a significantly higher

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incidence of women who had C_3 cortex in an older age group, no difference in distribution of women and men between MCI catagories C_2 and C3[16,20].
In present study 83% mandibular cortex (C_2 & C_3) had eroded in osteoporosis patient. Almost same, 84% of mandibular cortex had eroded in treated osteoporosis patient. Some studies have found that low bone mineral density is related with high MCI value (C_3) which can extrapolated to clinical practice[16,18,20]. 25% and 75% of women over 60 years has eroded mandibular cortex according to categories C_2 and C_2, respectively[11-13]. This result is more resembled to present study. Some studies have found that low bone mineral density is related with high MCI value (C_3) which can be extrapolated to clinical practice[20]. The result of present study showed 60% mandibular cortical bones were C_3.

Conclusion

We have described a statistical relationship of mandibular alveolar bone between osteoporosis patient and treated osteoporosis patient and MCI of osteoporosis patient. Mandibular cortical bone may be used as an indicator of osteoprosis diagnosis. Study should be conducted on large sample size for take accepted decision.

Disclosure

All the authors declared no competing interest.

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Original Article

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Effect of Post Type and Loading Condition on the Failure Resistance and Primary Failure Mode of Flared Canal Teeth Restored with Fiber Reinforced or Cast Posts

Farhana Sharmin[1*] Shahiqul Jabbar[2] Roxana Stegaroiu[3] Shuichi Nomura[4]

Abstract

Background: *This study investigated the influence of post type and loading condition on the failure resistance and primary failure mode of flared canal roots.* ***Materials and methods:*** *Post holes with flared canal were prepared in the roots of 40 intact human lower premolars. Twenty teeth received glass fiber posts with resin core (Fiber specimens) and 20 received cast post-and-core (Cast specimens). After cementation with resin cement,in 10 fiber and 10 cast specimens, a quasi-static bending test was performed by an Instron-type testing machine. In the other specimens, before the bending test, 3 years of intraoral function was simulated using a lever-type device. Failure resistance and primary failure mode in relation with post type and loading condition were statistically analyzed.* ***Results:*** *After cyclic loading, all specimens were intact, therefore, they underwent the bending test. Failure resistance showed a significant difference only for the post type.In the presence of cyclic loading, the post type significantly influenced failure resistance whereas in its absence, it showed only a tendency to influence failure resistance. In the cycled specimens, significantly fewer root fractures and more frequent debonding without root fracture were found in the fiber than in the cast specimens.* ***Conclusion:*** *Rather than cast post-and-cores, the use of glass fiber-reinforced posts and resin core for the restoration of flared canal teeth may prevent root fracture, but debonding may occur under high loads.*

Key words

Debonding;Fatigue loading; Fiberglass reinforced resins; Post and Core technique; Tooth fracture.

Introduction

Restoration of teeth with extensive caries that need pulp extirpation requires dowels (Posts) to retain the core that substitutes the coronal tooth structure[1]. For this purpose, custom cast post-and-core buildups or prefabricated metallic posts with resin cores have been traditionally used, but a series of short comings has become evident in time. A serious complication that often leads to tooth extraction is root fracture[2,3]. In vitro investigations of different post systems have found that teeth restored with cast or prefabricated metallic posts demonstrated most catastrophic failures by unfavorable root fractures[4-6].

Esthetic complications and allergic reaction to metal have been also related to metallic posts[7,8]. Therefore, non-metallic (Ceramics, carbon, glass or quartz fiber-reinforced resin, etc) posts have been added to the treatment options of endodontically treated teeth. Ceramics are tough materials with high compressive strengths, but are brittle when subjected to shearing forces and show less resistance to fracture than other non-metallic posts[4,9,10]. The carbon fiber posts are more resistant to fracture, but their black color can show through an esthetic crown[11].

On the other hand, glass fiber-reinforced posts are esthetic and, according to the manufacturer, their modulus of elasticity is 29.2 GPa, which is much closer to that of dentine (14.2 GPa) than dental alloys (90-100 GPa)[12-14]. For this reason, they are expected to be mechanically compatible with dentine, decrease the stress in the dental structure, and thus reduce the incidence of catastrophic root fracture. This supposition is supported by studies using structurally sound roots tested under quasi-static loads[4,6].

1. Assistant Professor of Prosthodontics
Chattagram International Dental College
Chattogram.
2. Associate Professor of Orthodontics
Chattagram International Dental College
Chattogram.
3. Associate Professor of School of Oral Health and
Welfare Faculty of Dentistry
Niigata University, Japan.
4. Professor, Division of Oral Health in Aging and
Fixed Prosthodontics
Niigate University Gradute School of Medical and
Dental School of Medical and Dental Science
Niigata, Japan.

*Correspondence to :
Dr. Farhana Sharmin
Cell: 01914 96 03 51
Email: drfarhana31@yahoo.com

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This study investigated the influence of post type and loading condition (Presence or absence of cyclic loading (9 x 10^5 cycles) that simulated the mastication pattern, equivalent of 3 years of clinical function, on the failure resistance and primary failure mode of roots with flared canals that were restored with posts and cores[13,14]. So the objective of this study was to investigated the influence of post type and loading condition on the failure resistance and primary failure mode of flared canal.

Materials and methods

40 freshly intact extracted lower premolar teeth were selected for this study. The teet were disinfected with 6% sodium hypochlorite solution (Purelox, OYALOX Co Ltd. Tokyo, Japan) and inspected under a stereomicroscope to check for caries, crack, stain and dimension. Intact teeth of similar dimensions were selected and stored in isotonic saline solution.

Each tooth was decoronated with a diamond point at the most apical level of the cementoenamel junction and the root section was flattened by a carborundum disk to obtain a surface perpendicular to the longitudinal tooth axis. All teeth were endodontically treated and a small quantity of zinc phosphate cement was filled on top of the gutta-percha and the specimens were stored in the saline for at least 7 days before canal preparation.The canals were prepared to receive posts to a depth of 8 mm with #1 through #3 Peeso reamers and #1 through #2 tapered reamers. On the lingual aspect, a keyway type ant rotational groove was also prepared with a diamond bur. Thereafter, the canal was flared in the cervical area by a conical carborundum point, to simulate the preparation required in gross carious destruction. In all the specimens, the mesiodistal width of the remaining tooth structure in the cervical area was at least 1mm on each side.

All the posts were fabricated by the indirect method. Cementation was performed with resin cement. After cementation and between the experimental steps that followed, each tooth was kept in saturated humidity at 37°C, using a hotting bath. Each root with restoration in place was fixed in the central hole of a resin block with an orthodontic resin applied in layers up to 2 mm below the root surface level. Prior to the cyclic loading, the artificial mobility of the restored teeth was evaluated by measuring the buccolingual deflection of the loading point with an electric micrometer in the same setting as for the mechanical test.

Half of the cast and half of the fiber specimens were firmly mounted in a brass holder of a custom-made lever-type fatigue testing machine[16]. Serrate-type cyclic loading between 0 and 2 kgf was applied to the buccal face of the core, 4 mm from the cemento-enamel junction. The load was applied at a rate of 80 cycles/min (1.33 cycles/s) for 900,000 cycles in a wet environment During each cycle the specimens were loaded for 0.3 The machine was equipped with 2 types of shutoff sensors to automatically discontinue loading in case of specimen failure.

In the specimen, in which no failure occurred after the cyclic loading and in those that did not underwent cyclic loading, a bending test was performed. The specimens were secured in an Instron-type testing machine (AG-1000E, Shimadzu, Kyoto, Japan) and an increasing load (Crosshead speed of 1 mm/min) with the same direction and location as in the mechanical cycling was applied until failure was recorded. For each specimen, the magnitude of the force causing failure was recorded in kgf. This corresponded always to a visible fracture of the root and in this case the primary failure mode was defined as “root fracture”. After the primary failure mode was identified, the testing machine was immediately stopped to avoid further destruction. Then, the roots were cut out of the embedment resin and the root surfaces were inspected by a stereomicroscope to check for additional fractures and/or marginal gaps.

Results

In the cycled specimens, no failure has been recorded at the end of the test, therefore, all the specimens are then subjected to the quasi-static bending test in the Instron-type testing machine. Since the failure resistance data shows normal and homogeneous distribution, they are analyzed by two-way ANOVA (2 x 2) (Table I) which shows a statistically significant difference for the factor post type ($p < 0.05$). However, no statistically significant difference is detect for the factor load condition, or for the interaction between the 2 factors ($p > 0.05$). The Tukey test shows that, in the presence of cyclic loading, the post type result in a statistically significant difference ($p < 0.05$) (Table II) with higher resistance of the cast specimens. In the absence of cyclic loading, post type shows a tendency to influence failure resistance, but without reaching significant difference ($p = 0.054$). Loading condition within both fiber and cast specimens do not significantly influence the failure resistance ($p > 0.05$).

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The aspect of the force-deflection curves, in combination with the visual and stereoscopic inspection of the failed specimens, revealed the following modes of failure, in 13 specimens, debonding of the post and core at the core-dentine interface, but no root fracture (Favorable failures) whereas in the remaining 27 specimens, root fracture (Unfavorable failures). In 22 of the root-fractured specimens, an oblique fracture line is visible in the cervical quarter of the root. This crack startes at the cervical surface of the root on one proximal aspect and descended towards the lingual aspect, on which itsmost apical level is observed about 1 mm beneath the embedment resin surface. In many specimens, the crack then rose on the opposite proximal aspect towards the cervical surface of the root where it ended. In other 5 specimens, 3 vertical root fractures and 2 apical root fractures were recorded. Furthermore, in 10 of the root-fractured specimens (5 cycled cast, 2 cycled fiber, and 3 non-cycled cast specimens) slight gaps are also observed microscopically at the core-dentine interface.

Table III shows the results of the Fisher's exact probability tests, in which the probability of an association between post type and occurrence of unfavorable failure (Root fracture) is analyzed for the cycled and non-cycled specimens, respectively. In the cycled specimens, significantly fewer root fractures are found in the fiber specimens than in the cast specimens ($p < 0.05$). However, no significant difference is found in the non-cycled specimens ($p > 0.05$). Table IV shows the Fisher's exact probability tests, in which the probability of an association between loading condition and occurrence of root fracture is analyzed for the fiber and cast specimens, respectively. In the fiber specimens, although a tendency of less root fractures is found in the presence than in the absence of cyclic loading, this difference do not reach significance ($p = 0.18$). In the cast specimens, no significant difference is found in association with loading condition ($p > 0.05$).

Table I : Results of the failure resistance values (kgf).

Source of Variation	DF	SS	MS	F	P
Post type	1	1056.578	1056.578	11.186	0.002
Load condition	1	5.837	5.837	0.0618	0.805
Post type x Load condition	1	25.536	25.536	0.270	0.606
Residual	36	3400.518	94.459		
Total	39	4488.470	115.089		

DF = Degree of Freedom, SS = Sum of Squares, MS = Mean Squares, F = Variance ratio, P = Probability

Table II : Results of all the pairwise multiple comparisonsof failure resistance values (kgf).

Comparison for	Within	Diff of Means	p	q	P	p<0.05
Load condition (Non-Cycled vs. Cycled)	Fiber	0.834	2	0.271	0.849	No
	Cast	2.362	2	0.769	0.590	No
Posttype (Fiber vs Cast)	Cycled	11.877	2	3.864	0.010	Yes
	Non-Cycled	8.681	2	2.825	0.054	No

Diff of Means = Difference of Means, p = number of means spanned in the comparison, q = Statistical datum derived in Tukey Test, P = Probability.

Table III : Comparison of the primary mode of failure (Occurrence/ non-occurrence of root fracture) between the cycled fiber and cast specimens, as well as between the non-cycled fiber and cast specimens.

Load condition	Post type	Root fracture but debonding	No fracture	p value
Cycled	Fiber	3	7	0.02
	Cast	9	1	
Non-Cycled	Fiber	7	3	1
	Cast	8	2	

Table IV : Comparison of the mode of failure (Occurrence/non-occurrence of root fracture) between the cycled and non-cycled fiber specimens, as well as between cycled and non-cycled cast specimens.

Post type	Load condition	Root fracture	No fracture but debonding	p value
Fiber	Cycled	3	7	0.18
	Non-Cycled	7	3	
Cast	Cycled	9	1	1
	Non-Cycled	8	2	

Discussion

The effect of post type (Cast or glass-fiber reinforced) on failure resistance and failure mode of restored teeth has been investigated and discussed else where therefore, the discussion will be mainly focused on the similarities and differences found in failure resistance and failure mode by the two experimental set-ups. In the oral cavity, the restoration "material-bond-tooth" structure is susceptible to chemical, thermal and mechanical influences[14,15,20]. Out of these, high loads that may develop during mastication, swallowing, or parafunctions (Such as clenching and bruxism) are expected to have the highest

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damaging effect on the restored teeth, therefore, in the present study, increasing loads are applied in a quasi-static bending test in both experimental set-ups. Furthermore, the above mentioned external demands on the oral environment, cause cyclic stress patterns in teeth and restorations.This is referred to as “cyclic loading”. In combination with other factors such as thermal and chemical influences, cyclic mechanical loading causes a large proportion of dental restoration failures[15,16]. Thus, in the first experimental set-up, before the bending test, a fatigue test is perform to simulate the effect of about 3-4 years of mastication[8,17,18]. The rate of the cycles (80 cycles/ min, that is 1.33 Hz) and the duration of actual loading during each cycle (0.3 s) are set according to the equivalent physiological parameters that have been reportedly measured during mastication[19,20]. Regarding force direction, it has been reported that, in vivo, the loading angle in the frontal planeis approximately 32.5° when the load magnitude is at maximum[21]. However, many in vitro experiments, including the present experimental set-ups, use a force perpendicular to the long axis of the endodontic post[19-21].The 90 degree angle of incidence between the compressive head and the long axis of the tooth specimen is chosen to simulate the worst case scenario of force application to a restoration and because the specifications for masticatory testing reportedly consisted of emulated mouth motion at 90° of loading angle[19-21]. In the first experimental set-up, the magnitude of the force during cyclic loading is 2 kgf, which is the upper value of the range reports for the lateral force peaks on molars[21]. Thus, the mechanical loading protocol set for this study slightly challenged the restored tooth, while still being within the physiological range. During mechanical testing of teeth, beside the applied loads, tooth constraints need also careful consideration, since they will determine the reaction to those forces. In vivo, the presence of the periodontal ligament with its receptors plays a decisive role in controlling the force level by displacement of the teeth during mastication[22]. In vitro, to reproduce the function of the periodontal ligament, several methods have been suggested[14,20,23]. Out of these, the use of cellophane tape wrapped around the tooth root (As in the present study) has been shown to allow atooth deflection that is similar to that reported in vivo[14,23]. Similar to other studies,in an attempt to roughly simulate bone, specimens of both experimental set-ups were embedded in an autopolymerizing acrylic resin (Modulus of elasticity of approximately 2.4 GPa,which is similar to the average stiffness of cancellous bone[24-26].

Mechanical fatigue tests conducted in a humid environment are considered methodologies with high predictability for the clinical performance of different materials and restorative techniques[27]. Therefore, in the first experimental set-up, the cyclic loading was performed in a humidenvironment, to simulate the long-term effect of saliva’s major component (Water) on the restorations. The luting agent used for all the specimens is a resin cement, furthermore, the glass fiberreinforced posts and the core resin in the fiber specimens also include composite resinpolymers, all of which, as an effect of aging, can become sensitive to the presence of water[27]. Water can act chemically at crack tips to decrease the strength of glasses, ceramics and composites[28]. Indeed, in the present study, the mechanical cycling in wet environment increased the contact time of the bonding interface with water, thus increasing the likelihood of debonding. This can explain why significantly more frequent debonding without root fracture are found in the fiber than in the cast specimens by the first experimental set-up, but no significant difference can be found by the second experimental set-up. Therefore, if failure mode of a post-and-core system is the parameter of interest, the selection of the test method should be carefully considered, since different results may be expected in the presence or absence of prolonged cyclic loading in humid environment. To investigate the influence of dental material aging on failure mode of post-restored teeth, testing under dynamic conditions in wet environment is recommended. Conversely, regardless of experimental set-up, fracture resistance was found to be significantly higher in the cast than the fiber specimens. Therefore, if fracture resistance is the output of interest, a quasi-static bending test alone might be sufficient, its results could be extrapolated to predict fracture behavior after an estimated period of 3-4 years of simulated oral function. However, for longer time span predictions, further studies with fatigue tests of more prolonged cyclic loading are needed. The results of this study also shade a new light on the way the reader of scientific literature should look at results of laboratory tests of post-restored teeth. Particularly, if failure mode of thos eteeth is the topic of interest, along with the test results, the test methods and testing conditions should be also carefully considered, to enable an appropriate extrapolation to clinical settings. This is also valid for advertised properties of new dental materials, as claimed in a recent trend of rethinking the reliability and validity in dental material testing.

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Conclusion

Within the limitations of this study, the following conclusions were made:

i) Rather than cast post-and-cores, the use of glass-fiber reinforced posts and core build-up material for the restoration of flared canal teeth may prevent root fracture, as found in a fatigue test that simulated 3 years of mastication followed by a quasi-static bending test. However, debonding, a reversible complication, may more frequently occur in these fiber-post teeth under high buccolingual loads.

ii) After 3 years of simulated mastication, flared canal teeth restored with cast post-and-core resisted to significantly higher loads than those restored with fiber posts, but when they failed, significantly more unfavorable failures (Root fractures) were recorded.

iii) The application of 900,000 cycles of load tended to influence primary failure mode in the fiber specimens only, and it did not significantly affect failure resistance. Prolonged cyclic loading needs to be performed to elucidate the effect of loading condition on the failure resistance/mode of restored teeth.

Disclosure

All the authors declared no competing interest.

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Original Article

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Status of Preventive Practices on Hepatitis-B Among the Dental Health Care Personnel in Kumilla, Bangladesh

Md. Al-Amin[1*] Md. Abu Saeed Ibn Harun[2] Sadia Afrin[3]

Abstract

Background: *Like other health care workers, dental Personnel are at an increased risk of exposure to HBV. Dentists are less concerned about becoming infected with infectious hepatitis, and are Less frightened to treat patients with this disease.The aimof this study was undertaken to find out the prevailing status of preventive practices among the DHCP in some selective dental clinics in Comilla.* ***Materials and methods:*** *A cross-sectional survey conducted among 426 dental health care professional in Kumilla District. Those who refused to attained in this study were excluded. All subject were answered on preformed questionnaire.* ***Results:*** *The result showed that 197(46.24%) had taken vaccine against Hepatitis B virus and rest of 229 (53.75%) did not receive vaccine ever. 187 (43.9%) had been taking patients detail history regularly but other than that, 194 (45.54%) not taking history. 45.3%(193) had been using disposable gloves during dealing with the patients while 54.7% (233) not using disposable gloves, this directly related to the monthly income of the respondent. 34.98%(149) has been using face mask regularly while others 65.02% (277) not using face mask. 72.06% (307) respondent reported that , they had used disposable needles for individual patient. 295(69.24%) using sterile surgical instruments during operating patients and about 24.17% reused a needle for more than one patient.* ***Conclusion:*** *Dental technician are poorly educated to enhance their level of infection and transmission control.*

Key words

Dental Healthcare Personnel; Hepatitis-B; Preventive measures.

Introduction

Hepatitis B is an acute inflammatory disease of the liver or a form of viral hepatitis caused by the hepatitis B virus[1]. It is a common cause of liver disease throughout the world[2]. An estimated one third of the world's population has serologic evidence of past infection, and the virus causes more than 1 million deaths annually[2,3]. The Slogan of the world hepatitis day, 2009 was "Am I number 12?". This means that, one in twelve of world's total populations are infected with hepatitis B or C Currently, there are four recognized modes of transmission are i) From mother to child at birth (Perinatal) ii) By contact with an infected person (Horizontal) iii) By sexual contact. iv) By parenteral (Blood-to- blood) exposure to blood or other infected fluids[4,5]. There is considerable variation between areas, countries and continents as to the age at which most transmission takes place. There can be carriers with or without hepatitis. HBsAg has been found in all body secretions and excretions. However, only blood, vaginal and menstrual fluids, and semen has been shown to be infectious. Transmission occurs by percutaneous and per mucosal exposure to infective body fluids. Percutaneous exposure that have resulted in HBV transmission include transfusion of unscreened Blood or Blood products, sharing unsterilized injection needles for IV drug use, haemodialysis, acupuncture, tattooing and injuries from contaminated sharp instruments sustained by hospital personnel. Sexual and parental HBV transmissions usually result from mucous membrane exposures to infectious blood and body fluids. Per natal transmission is common in hyper endemic areas of south-east Asia and the far East, especially when HBsAg carrier mothers are also HBsAg positive. Infection may also be transmitted between household contacts and between sexual partners, either homosexual or heterosexual, and in

1. Lecturer of Children, Preventive and Community Dentistry (Former) Chattagram International Dental College Chattogram.
2. Assistant Professor of Conservative Dentistry & Endodontics Chattagram International Dental College Chattogram.
3. Resident Dental Assistant Ontario, Canada.

*Correspondence to :
Dr. Mohammad Al-Amin
Cell: +1(647) 907-0431
Email: motaher_amin@yahoo.com647-907-0431

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the toddler-aged children in groups with high HBsAg carrier rates. The amount of blood or serum necessary to transmit the infection is as little as 0.01 ml[6]. Contaminated needles and medical equipment can be the cause of Hepatitis "B" virus transmission even months after being soiled by the virus[7]. Indirect inoculation of HBV can occur via inanimate objects like toothbrushes, baby bottles, and toys, razors, eating utensils, hospital equipment and other objects, by contact with mucous membranes or open skin breaks[8]. Infectious HBV can be present in blood without detectable HBsAg, so that the failure to detect antigen does not exclude the presence of infectious virus[9].

The source of infection cannot be identified in about 35% of cases. The natural reservoir for HBV is man. Closely related hepadna viruses have been found in woodchucks and ducks, but they are not infectious for humans. The reuse of the same unsterilized needle and syringes for vaccination of many different children accounts for many unnecessary HBV infections[10]. People depending on repeated transfusion should be vaccinated against HBV. HBV is about 100 times more infectious than HIV[4,11-14].

Hospital personnel, particularly operating room staff, and laboratory technicians, who handle blood have an increased risk of accidental parental exposure to hepatitis infection was found in 16.8% of health care personnel and in only 8.7% of control group matched for age, sex, and socioeconomic status[15].

The risk of health care workers contraction of HBV depends on how often they are exposed to blood or blood products through percutaneous and per mucosal exposures. Any healthcare or public safety workers may be at risk for HBV exposure depending on the tasks performed. If those tasks involve contact with blood or blood contaminated body fluids, then such workers should be vaccinated. Risk is often highest during training periods. Therefore, it is recommended that vaccination should be completed during training in schools of Medicine, Dentistry, Nursing, laboratory, technology and other allied health professions[16]. In Bangladesh, prevalence of hepatitis- B infection is 4-7% and 6,023, 560 people are HBsAg positive[17].

For Prevention and control active immunization is done by Hepatitis B Vaccine containing HBsAg. Passive immunization is done by intramuscular injection of Hyper Immune Serum Globulin (HBIG) containing anti-HBs. this should be given within 24 hours, or almost a week, of exposure to infection. Avoiding risk factors such as shared needles, syringes, razors, multiple male homosexual partner and prostitutes. Screening blood for presence of HBV before transfusion should be done. Physicians, surgeons, dentists, nurses should be more careful to avoid getting HBV from infected patients. In 1992, WHO recommended that developing countries with high hepatitis B Virus infection burden should introduce hepatitis B vaccine into their routine national immunization programme by 1997[18]. Bangladesh still cannot do successfully due to economic constraints[19]. An additional target was added by WHO in 1993, that 80% reduction in the incidence of HBV infection carriers by 2001[9]. The GAVI partners in 2000 set a new milestone to reach its hepatitis B immunization goals. This millstone is for hepatitis B vaccine to be introduced in all poor countries with adequate delivery systems by 2007[20]. In 2004, 153 countries were using Hepatitis B Vaccine in their routine infant immunization programme, and the global hepatitis B vaccine coverage rate was 48%[21]. Among countries eligible for support from the GAVI Alliance, six countries have the greatest number of children not immunized, India, China, Bangladesh, Ethiopia, Nigeria, and Congo. Bill gates and Melinda Gates Foundation for children's vaccination programme, which has initiated aid for Hepatitis B Vaccine in Bangladesh and India, could help make immunization against HBV infection[21]. Introduction of Hepatitis B Vaccine in the routine EPI schedule in 2003 under GAVI support has been a mile stone in the history of health sector of Bangladesh[21].

Materials and methods

A cross-sectional survey conducted among 426 Dental Health Care Professionals in Kumilla District. This questionnaire based study was conducted from June 2009 to November 2009. Those Dental Health Professionals (DHHP) who denied to participate in the study were excluded. All included subject were answered in preformed questionnaire. The data were analyzed by using software SPSS version 11.5.

Results

This cross sectional type of descriptive study was carried out in Kumilla district to assess the present status of preventive practices on Hepatitis-B among the Dental health care personnel in Kumilla. A total 426 dental health care personnel including dental specialist, general dentist, dental hygienist, dental assistant, lab technician were undertaken. A pre tested questionnaire was use to collect the information. Among the 426 respondents majority are 17 to 26 years (35.45%)

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28.88% are 27 to 36 years, 32.87% are 37-46 years and 2.81% are 47-56 years. Out of the participants, greater number are dental assistants (35.26%) second majority respondents are dental lab technicians (28.17%) General Dentists (14.8%) and 2.58% are Dental surgeons with post graduation degree (Table I). Within the respondents 59.1% (252) are male and 40.8% (174) are female. 90.84% of participated dental health care personnel are aware about the necessity of Hepatitis B virus vaccination for self protection against Hepatitis B Virus infection as a heath service provider. From the data 197(46.24%) has taken vaccine against Hepatitis B virus and rest of 229 (53.75%) do not receive vaccine ever (Figure 1). 45.3% (193) has been using disposable gloves during dealing with the patients while 54.7% (233) not using disposable gloves, this directly related to the monthly income of the respondents (Figure 2). 34.98% (149) has been using face mask regularly while others 65.02% (277) not using face mask (Figure 3). 72.06% (307) respondent reported that, they used disposable needles for individual patient. 295(69.24%) using sterile surgical instruments during operating patients and about 24.17% reused a needle for more than one patient (Figure 4).

Table I : Distribution of Age of the respondents (n=426).

Age of the respondents (Years)	Frequency (n)	Percentage (%)
17-26 (Years)	151	35.45%
27-36 (")	123	28.88%
37-46 (")	140	32.87%
47-56 (")	12	2.81%

Table II : Distribution of Scio Demographic Characteristics of the respondents (n=426)

Category of dental health care personnel		
Specialist (Post graduate)	11	2.58
General dentist	63	14.8
Dental hygienist	47	11.05
Dental assistant	150	35.21
Lab technician	120	28.17
Quack	35	8.21
Educational level		
Diploma	352	82.63
Graduate (Bachelor)	63	14.8
Post graduate	11	2.58

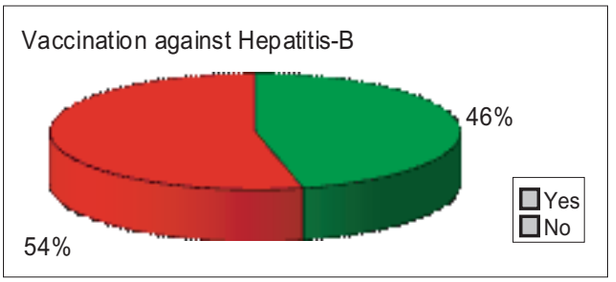

Figure 1 : Received vaccination against Hepatitis-B.

Figure 2 : Use of disposable gloves during clinical work.

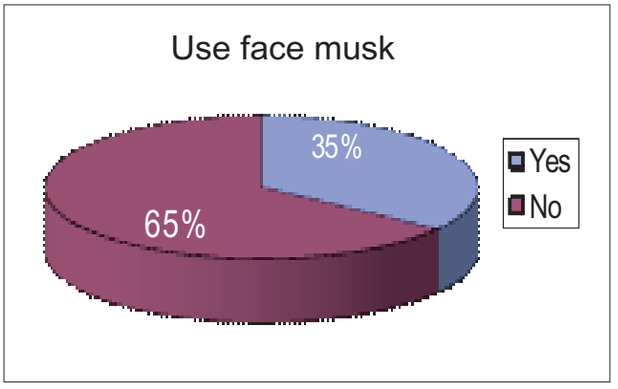

Figure 3 : Use of face musk during clinical setting.

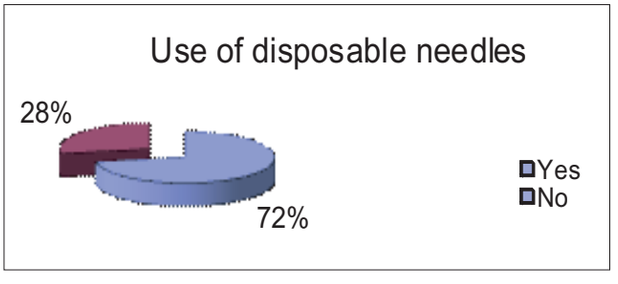

Figure 4 : Use of disposable needles during clinical sitting.

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Discussion

The present descriptive type of cross sectional study was conducted among 426 dental health personnel in Kumilla District including dental specialist (Post graduate) general dentist, dental hygienist, dental assistant, lab technician were undertaken. This study in respect of socio-demographic characteristics of the respondents. They were as follows: age, religion, category of dental health care personnel, educational level, monthly income, marital status and sex. Among the 426 samples, the age of the respondents were within 17 to 56 years. Majority of them within 17 to 26 years of age (35.45%) among 27 to 36 years (28.88%), among 37 to 46 years (32.87%) and 2.81% 47 to 56 years of respondents.

Category of dental health care personnel were the most important marker to evaluate the status of preventive practice on Hepatitis-B. From the table we can find that, out of 426 sample majority of the respondents are dental assistant (35.21%) second majority respondents were lab technician (28.17%) general dentist (BDS graduate) were 14.8% and only 2.58 % were post graduate.

Educational level of the participants was one of the important determinants to asses the preventive practice about Hepatitis-B. In the analysis out of 426 respondents most of them are diploma degree 83.63% (352) graduate dentist 14.8% (63) and post graduate only 2.58% (11).Knowledge of the respondents about Hepatitis-B was the most important marker to evaluate the status of preventive practice on Hepatitis-B.Among the 426 respondents, about 90.84% dental health care person know about Hepatitis-B.

How hepatitis-B is transmitted to human is the most important thing about the precaution that have to taken for the prevention of hepatitis-B.Among the 426 dental health care personnel, it is noted that 181 (42.48%) were agree that unsafe sex can cause hepatitis-B, 50.0% (213) did not agree and rest of the 7.51% (32) doesn't know about it. 250 (58.68%) agreed that infected blood transfusion can cause hepatits-B,33.1% (141) did not know this information.

Sharing common needles can cause hepatitis-B that has been agreed by 77% (328) of the respondents, 21.36% (91) did not know about this information. Contaminated food can cause hepaitits-B,56.33% (240) respondents disagreed with this information.147 (34.5%) respondents agreed with this information. Child can be affected by hepatitis-B from infected mother 38.73% (165) respondents knew this but 29.58% (126) respondents did not know about this information. Other mode of transmission like use of same razor or tooth brush can cause hepatitis-B, 83.33% (355) respondents knew this. Health care person can be a vulnerable group of hepatitis-B because they were using sharp surgical instruments or reamer, file explorer for endodontic treatment in their work, 405(95.07%) respondents knew this. So we can say that dental health care person had more or less good knowledge about hepatitis-B.In the present study we had also taken information about high risk group of hepatitis-B.

If a person has multiple sexual partners they have more chance to develope hepatitis-B,266 (62.44%) respondents knew this information. Infected blood or blood seller can be a risk group for development of diseases, most of the respondents 245 (57.51%) knew that but 37.33% (159) did not know that. Dental health care person can be a high risk group of hepatitis-B agreed by 273 (64.08%) respondents, 87 (20.42%) respondents did not agree and other 66 (15.5%) did not know about this information. Among the 426 respondents, 56.33% believe that infancy was the best time for vaccination and other 38.16% (137) knew that adult can also take hepatitis-B. In the present study it was found that 167 (39.21%) respondents knew that hepatitis-B had only single dose of vaccination.120 (28.16%) 32.63%(139) did not know about this information.

Vaccination against hepatitis-B is needed for self protection of service provider. From the data of 426 respondents it was reported that 197 (46.24%) had taken vaccine against hepatitis-B and rest of 229 (53.75%) did not receive vaccine ever.

Before operating patient it is very important to take detail history of patient for the safety of operator as well as patient. From the above data 187 (43.9%) had taking patients detail history regularly but other than that,194 (45.54%) did not take history, most of them were diploma graduate dental hygienist or dental assistant but graduate dentist were more likely to do so.45 (10.56%) had taken history occasionally.

Among the 426 respondents, 45.3% (193) were using disposable gloves during operating patient while 54.7% (233) did not use disposable gloves; this is directly related with the monthly income of dental care provider.

Among the 426 respondents 34.98% (149) were using face musk regularly. While other 65.02% (277) were not using face musk.72.06% (307) respondents reported that they had used disposable needle to every patient.295 (69.24%) out of 426 respondents give information that they had used sterile surgical instrument during operating patient. About 24.17% were using common needles to multiple patient.Two general

limitations of the study must be considered when interpreting the results. Although the demographic characteristic of our study sample represent all dentists of Kumilla, the voluntary nature of the study may have introduced selection bias.

Conclusion

The Dentists had good knowledge and attitudes regarding Hepatitis-B and its transmission, but that the infection control measures among the Dental Hygienists, Dental assistants, Dental technicians are moderately poor and there is need for educational program for Dental Health care workers to enhance their levels and reducing the risk of infection transmission.

Disclosure

All the authors declared no competing interest.

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Review Article

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Recent Development in Central Giant Cell Granuloma

Md. Ali Hossain[1] Shahiqul Jabbar[2]

Abstract

Background: *Central Giant Cell Granuloma is anonneoplastic intraosseous lesion, and constitutes a common nonodontogenic pathology to occur in the jaws.It is characterized histologically by cellular fibrous tissue containing multiple foci of haemorrhage, aggregations of multinucleated giant cells, and occasionally, trabeculae of woven bone. The aim of this review to described the recent development in research of Centre Giant Cell Granuloma.* ***Materials and methods:*** *An initial literature search of database of the search term yield 13 open access full text article.Among those 5 articles were included in this review as they were reported in recent developments of research in Central Giant Cells Granuloma.* ***Results:*** *Some of the lesions were thought to display a markedly 'aggressive' behaviour and a clinically 'aggressive' model of CGCG had been proposed. Smaller, 'nonaggressive' tumours generally respond very well to conservative enucleation or curettage but recurrence were seen to be common with 'aggressive' lesions.* ***Conclusion:*** *Various medical therapies including injections of intra lesional steroids, subcutaneous calcitonin and interferon have been proposed for the treatment of 'aggressive' lesions.*

Key words

Giant cell lesion;Nonodontogenictumours of jaws; Central Giant Cell Granuloma; Giant Cell Tumour.

Introduction

Central Giant Cell Granuloma (CGCG) is a commonly seen pathology in the jaws. During the last few years, they have been the centre of an active debate and research among the clinical scientists in the field of Oral & Maxillofacial Surgery and Pathology. Still, the literature does not reach a consensus on the designation of the most correct term for these lesions. They have been labeled as central giant cell granuloma, central giant cell 'reparative' granuloma, giant cell lesion, and 'benign' giant cell tumours by various researchers. (In the succeeding discussion on these lesions, we have stuck to using CGCG as it is the most frequently used term, readers can also use the more noncommittal term 'giant cell lesion'[1-4].

1. Associate Professor of Oral and Maxillofacial Surgery
Chattagram International Dental College
Chattogram.
2. Associate professor of Orthodontics
Chattagram International Dental College
Chattogram.

*Correspondence to :
Md. Ali Hossain
Cell: 01914 96 03 51
Email: hossyne@hotmail.com

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This stems from an etiopathogenesis that is not still properly understood.

The true nature of CGCG is unknown, and they have not been able to be ascertained as either a reactive, hamartomatous or neoplastic process. It can be that there is a reactive form (Nonaggressive CGCG) and a neoplastic form (Aggressive CGCG) and scientists have not been able to devise tools to scientifically separate the two[5]. What is agreed upon at is their clinical behavior which marks them as progressive lesions that can be aggressive. The origin is unknown, but there are indications that genetic abnormalities may be implicated[6,7].

Nevertheless, they are defined by the World Health Organization as an intraosseous lesion consisting of cellular fibrous tissue containing multiple foci of haemorrhage, aggregations of multinucleated giant cells, and occasionally, trabeculae of woven bone[8].

Two lesions closely related to CGCG are GCT of long bones and GCRG of small bones and comparative literature review indicates that these lesions are histologically and phylogenetically similar[9-11].

Search Strategy

The google scholar database were queried for relevant articles to the topic of dental stem cells in regeneration. The search terms were following key word used in various combination: Dental Pulp, Stem cells, Bone tissue engineering, Tissue repair, Cell therapy. Total 13 open access full text articles were found. But 5 articles were included in this review due to they reported the recent developments of Central Giant Cell Granuloma.

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Etiopathogenesis

The exact process behind pathogenesis of CGCG remains unknown. While the giant cell remains to be the most prominent feature of these lesions, it is actually the mononuclear spindle cell which is the proliferating cell (In cell cycle). This is indicated by the expression of the cell cycle protein Ki-67 in CGCGs. It is believed by some that this spindle cell (Fibroblast or fibroblast-like) recruits monocytes from the vascular system and induces them to differentiate into osteoclastic giant cells through release of cytokines[9,12]. It has been proposed that this spindle cell takes its origin from the mesenchyme of marrow and an epigenetic event (Poorly understood) signals them to release cytokines and finally the osteoclastic giant cell causes bone resorption making the hallmark feature of CGCG[5].

Another hypothesis is that CGCG is a vascular proliferative lesion, which means that angiogenesis under the influence of the tumour cells is required for tumour growth, invasion, and destruction of local tissue. The possible spontaneous involution theory favours this hypothesis.

Are they really 'reparative'?

The original description of CGCG branded it 'reparative' in nature and self healing, and it was supported by Worth who reported a series of CGCG that were not surgically treated but followed radiographically and appeared to resolve spontaneously[12,13]. A biopsy several years later yielded only a fibrous scar. It was further lent support by the data that these lesions are generally found in young people 7 to 25 years old and are rarely found in older people, which further supports a spontaneous healing theory.

However, some authors opine that as the clinical behaviour of many of these lesions is inconsistent with a reparative reaction, the designation central giant cell granuloma or the more noncommittal term, giant cell lesion, is more widely used today[13].

Clinical Features

Though CGCG is one of the commonest intrabonynonodontogenic pathology seen at our centre, it occurs less commonly than its peripheral counterpart (PGCG). Lesions are found predominantly in children and young adults, with most cases (As high as 75 %) presenting before 30 years of age. Females are affected more often than males, in a ratio of 2 to 1[1,13].

CGCG occurs almost exclusively in the mandible followed by anterior maxilla, although isolated cases in facial bones have been reported. They tend to involve the jaws anterior to the permanent molar teeth, with occasional extension across the midline. Rarely, the lesions involve the posterior jaws, including the ramus and condyle.

CGCG typically produces an asymptomatic painless expansion or swelling of the affected jaw. Cortical plates are thinned, with sometimes perforation but gross soft tissue involvement is rare as often remains limited to its effects on periosteum.

Besides the similar features with the Brown Tumour of Hyperparathyroidism and Cherubism, it has also been associated with Neurofibromatosis-Type I or Neurofibromatosis-Type I with a Noonan-like phenotype[14].

Radiological Ffeatures and Related Differential Diagnoses

The CGCG may occur initially as a unilocular, cystlike radiolucency, but as it grows larger, it frequently develops an architecture that causes a soap-bubble type of multilocular radiolucency[15].This multilocular soap-bubble appearance is associated with a later presentation, and is one of the commoner radiographic patterns seen in patients with CGCG at our centre.Differentresearchers have reported the unilocular lesions to comprise 39 to 84 % of the total number of CGCGs[14,15].

Generally, if the lesion is located anterior to the permanent molars and possibly crossing midline, with a multilocular radiographic patternwith the patient under 30 years of age, a provisional diagnosis of CGCG can be considered[15]. However, if the biopsy proves it to be a case of CGCG, serum chemistry for hyperparathyroidism has to be done to exclude Brown Tumour. Furthermore, in multiple lesions of CGCG, possibilities of cherubism and Noonan syndrome also have to be considered.

The radiological differential diagnosis can include Ameloblastoma, odontogenic keratocyst and Aneurysmal Bone Cyst, and sometimes also odontogenic myxoma and central haemangioma of bone (The latter two often exhibit more of a honey-combed appearance though). For patients in the young age range for CGCG, ameloblastic fibroma, cemento ossifying fibroma (early stages), and adenomatoid odontogenic tumor might be added to this list[15].

The borders of the lesion have been reported as well defined in 56 % of cases, poorly defined in 30 % of cases, and diffuse in the remaining 14 %[16].They are generally seen to be well delineated, but the margins are generally noncorticated.[17]Whitaker and Waldron showed that though most of the 142 cases of CGCGs in their study were well delineated, only 19 % showed well-corticated borders[17].

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Histopathology & Related Differential Diagnosis

CGCG is composed of uniform fibroblasts in a stroma containing various amounts of collagen. Haemosiderin-laden macrophages and extravasated RBCs are usually evident, although capillaries are small and inconspicuous. Multinucleated giant cells are present throughout the connective tissue stroma, and they may be seen in patches or distributed evenly. It has been reported that the multinucleated giant cells exhibit characteristics of the osteoclasts phenotype[11, 18,19]. Others suggest these cells may be aligned more closely with macrophages[20]. In some cases, the stroma is loosely arranged and oedematous; in others, it may be quite cellular[17]. Foci of osteoid may be present, particularly around the peripheral margins of the lesion. Although red cell extravasation can be extensive in some CGCGs, it does not makes these lesions fundamentally vascular, as the proliferating cells are not endothelial cells. The red cell extravasation can probably be explained by vascular permeability caused by cytokine release through mononuclear spindle cells.

There are various conditions which 'mimic' the histological presentation of CGCG. The histopathological differential diagnosis includes PGCG, GCT, Brown Tumour of hyperparathyroidism, Cherubism, ABC and Fibrous dysplasia.

PGCG is inseparable histologically from CGCG and it is the clinical manifestation of a peripheral, soft tissue origin in case of PGCG that distinguishes the two.

GCT of long bones can sometimes be differentiated from CGCG because of larger giant cells with more nuclei and a homogenous pattern. Malignancy in GCT of the bone was reported by Bertoni et al in 1.8% of the cases described[20]. These malignancies can be either primary or secondary, including giant cell-rich osteosarcomas, fibrosarcomas, and malignant fibrous histiocytomas[20]. Some authors have regarded the GCT and CGCG as a continuum of the same disease process, by reporting some histopathological pictures of 'aggressive' CGCGs which were totally indistinguishable from GCT of long bones.[3,21].This led these scientists to believe that CGCGs and GCTs of the extragnathic skeleton are not distinct and separate entities but rather represent a continuum of a single disease process modified by the age of the patient, location, and possibly other factors that are as yet not clearly understood. There have been a few case reports of a reported GCT occurrence in the jaws that metastasized or locally transformed into a malignancy which fail to clearly report a spontaneous malignant transformation of a previously benign CGCG[21]. What is unclear in most of them that whether it was a primary bone malignancy (Osteosarcoma, chondrosarcoma etc.) with a large giant cell population or a radiation-induced sarcomatous change.

Brown Tumour of hyperpathyroidism is histologically indistinguishable from CGCG. Termed brown as the haemosiderin-laden tissues give it a brown-coloured appearance, it is imperative to exclude Brown Tumour after every histological diagnosis of CGCG. Serum Chemistry consisting of Calcium, Phosphorus and Parathormone profile along with the classic manifestations of stones (Renal stones) bones (Bone changes) moans (Psychic moans) and groans (Abdominal groans) are used to assess bone lesions in hyperparathyroidism.

Cherubism is an autosomal dominant disorder with bilateral involvement. Though it may be difficult to distinguish Cherubism from CGCG histologically, Cherubism is seen to have a distinct clinical presentation. It includes multifocal and multilocular cystic lesions of the jaws[22,23]. Early stages of Cherubism may initially present with a single obvious lesion on one side of the jaw and additional lesions which are quite smaller and rather difficult to detect[24]. Mainly in young patients with large lesions in the posterior region, very thorough radiographic examinations (Intraoral occlusal radiography, CT with 3-D reconstruction) can be performed to rule out the possibility of additional lesions being part of an evolving cherubism. As a rule of thumb, cherubism is diagnosed on clinico-pathological grounds. In some lesions, however, the characteristic eosinophilic perivascular cuffing has been noted[25].

The diagnosis of Aneurysmal Bone Cyst (ABC) is made by the identification of sinusoidal blood spaces within the tumour mass, and sometimes by aspiration of blood preoperatively.

Fibrous dysplasia shows only limited foci of giant cells. There are no defined margins radiographically, as it merges imperceptibly with the surrounding bone, atleast in maxilla where it is most commonly encountered. Moreoever, growth in fibrous dysplastic lesions normally ceases with maturity[26].

Besides the cell cycle protein Ki-67 which is overexpressed which may lead to a dysregulation of the cell cycle, CGCGs have an overexpression of the MDM2 protein/gene, and it is proposed that it might be the control protein/gene of the proliferating spindle cells[27]. p53 (A protein with antiproliferative and apoptosis-promoting effects) is not known to have an altered

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expression in cases of CGCGs[24]. By using DNA microarrays containing 19,200 genes, Carinci et al identified several genes who expression were signicantly up- or down-regulated, and thus presented a genetic profile of CGCG[28]. These expressed genes cover a broad range of functional activities, cell cycle regulation, signal transduction, and vesicular transport. Those among upregulated genes include AKAP 12 (A-Kinase Anchor Protein 12) STMN1, CNTFR, ELK1 and HSPG (Heparan Sulphate Proteoglycan). Downregulated genes include TM4SF2 (Transmembrane 4 Superfamily 2) DDA3 and MPP3. It is hoped that this genetic portrait can be used to distinguish between 'aggressive' and 'nonaggressive' lesions by monitoring the relative expression in each of them.

'Aggressive' vs 'Nonaggressive' Lesions

Some authors have suggested that a more 'aggressive' form of CGCG may exist, but efforts to identify such a variant histologically or by immunohistochemistry have not yielded concrete results[7,29]. It has been shown that 'aggressive giant' cell lesions may have a higher relative size index of giant cells, with an increased rate of mitosis and less osteoid formation at the periphery,but the results have varied and have largely remained inconclusive. However, an 'aggressive model' of CGCG has been proposed on the basis of clinical and radiological findingswhich characterizes aggressive giant cell lesions on the presence of pain, paraesthesia, a size of more than 5 cm, rapid growth, tooth displacement or root resorption and cortical bone thinning or perforation[29].

Recurrent lesions, regardless of size, would be considered 'aggressive', and may form the strongest indicator of 'aggressiveness'. These 'aggressive' type of CGCGs are seen to be commoner in younger patients with a mean age of 10.7 years compared with an average age of 22.5 years for 'nonaggressive' lesions[4,30,31]. Kruse-Losler et al. have held tumour size to be the most reliable indicator of the 'aggressiveness' and prognosis[24]. Such clinical features should be accounted for to improve the individual planning of the treatment and thence, follow-up.They are thought to comprise of 19.3 % of all CGCGs[32].

So it could be that there is a neoplastic 'aggressive' variant and a reactive 'nonaggressive counterpart. However, we think that keeping the general health attitudes and other socioeconomic demographic features in mind, patients with smaller, 'nonaggressive', asymptomatic, painless lesions do not seek care early in the course of the disease. Believing the 'reparative' theory, these lesions may 'involute' with time and if some of them 'do not involute', it is often one of the symptomatic feature (Such as pain or a grossly enlarged swelling) of the lesion that makes them present to the hospital. 'Aggression' in that scenario, then becomes more duration dependent than the actual clinical behaviour of the lesion. It is therefore, pertinent to mention that tooth displacement with or without root resorption is seen invariably in almost all cases seen at our setting. Incidental finding of a brewing small giant cell lesion is, if at all, a remote possibility.

Surgical Therapy

The more problematic of the CGCG are the histologically similar, clinically aggressive variants and en bloc resection with negative histologic margins might be the gold standard in these lesions. However, the obviously increased morbidity with a more aggressive surgical procedure carries its own disadvantages. Traditionally, surgical curettage has been relied upon as the treatment of choice for CGCGs. Nonaggressive lesions in the jaws respond to simple curettage but aggressive lesions have reported recurrence rates from 11 to as high as 70 % after enucleation or curettage[3,30,31]. Therefore, for more aggressive lesions, surgical therapy alone may not suffice. In these cases, curettage has been combined with adjunctive therapies comprising of peripheral ostectomy, cryotherapy with liquid nitrogen, use of Carnoy's solution, radiotherapy, or postoperative use of Interferon-α, all providing satisfactory to excellent results[32].

Medical Therapy

In patients with aggressive lesions, several alternatives to surgery are being investigated. Although a seemingly high success rate is reported with each of the following medical treatment modalities, inherent flaws mark the rationale of their use as none of these therapies targets the spindle cell hypothesized to be the main cell behind the etiopathogenesis of CGCG. Moreover, agents that have the potential to block the action of osteoclasts are currently available. It might also be that the 'reparative' theory holds true and these medical therapies only trigger the regression of these lesions. Multi-centre clinical trials making use of larger samples with similar variables and protocols comparing the different modalities would enable us to reach the most appropriate conservative non-surgical therapy.

1. Intralesional Steroids

Intra lesional steroids have already been used with success for treatment in unicameral (Simple, Solitary, Traumatic, Haemorrhagic) bone cysts in long bones[33].

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It has been demonstrated that there is a steroid-dose-dependent decrease in the secreted level of bone resorbing enzymes (eg. cathepsin B, cathepsin L, beta glucoronidase, lysozyme, and tartrate-resistant acid phosphatase) secreted by Osteoclasts. Moreover, steroids may have an apoptotic action on osteoclasts-like cells[34]. It can also be that steroids may act by suppressing any angiogenic or inflammatory component in the lesion. However, it remains surprising to get good results with steroids that are otherwise known to affect bone resorption and osteoporosis.

Intralesional injections of an aqueous solution of triamcinolone with either 2% Lidocaine or Bupivacaine, 50% mixture by volume are used. The solution is administered withy a 5-cm disposable syringe, delivering a dose of 30 mg in adults and 25 mg in children. The site of injection is gauged by clinically estimating the site where cortical bone is more expanded and thinnest and once inside the lesion, small amounts are injected into different areas. These injections are repeated every 3 weeks and the treatment is limited when there is a significant amount of resistance caused by the bone being formed and calcified[34]. No side effects are reported.

2. Calcitonin Therapy

First advocated by Harris in 1993, a number of reports in literature have shown it to be a worthwhile treatment of CGCG[35-38]. Based on the pretext that as CGCG appears similar albeit histologically to Brown Tumour of hyperparathyroidism, there may be a circulating Parathyroid related hormone that causes these lesions. However, this hormone, if it exists, has not been identified. Even though it may be the stromal cells, or fibroblasts that are the etiologic cells of CGCG and the giant cells themselves may be secondary or reactive, agents targeting the stromal cells are currently unavailable. On the other hand, Calcitonin receptors have been identified on the giant cells of the lesion, antagonizing osteoclastic bone resorption[19,39].Calcitonin therapy takes longer to affect CGCGs. On the other hand, patients with aggressive CGCG especially with those in a younger age group with associated pain or paraesthesia require a more immediate response and a possible criticism of calcitonin therapy is its delayed effect[39].

A suggested treatment regimen is 100 IU of calcitonin (Salmon or human) per day, subcutaneously till it is ascertained radiographically that there is no further resolution of the disease. This was seen in one study to be between 19 and 21 months. Intranasal route has also been suggested, although the absorption of the nasal spray is known to be erratic and can vary between 20 % to 100 % absorption[39].

3. Interferon-2α

In 1980, interferon alpha-2a was found to inhibit angiogenesis through a series of experiments in the laboratory[40]. Interferon alpha has already been used to treat patients with metastatic or locally advanced, nonresectable giant cell lesions of the long bones that have recurred after previous surgery or radiation therapy[41]. This therapy derives its rationale from the hypothesis that as CGCG is a tumour that is characterized by proliferation, marked vascularity, and bone resorption, and thus it is feasible to consider it as an angiogenic disease. Interferon also appears to encourage bone formation through stimulation of osteoblasts and preosteoblasts and inhibit bone resorption[42,43].

After necessary preoperative workup, a nerve- and teeth-preserving enucleation is carried out. Interferon alpha-2a or interferon alpha-2b is started 48 to 72 hours postoperatively at a dose of 2,000,000 – 3,000,000 units/m^2 administered once dailysubcutaneously. During treatment, patients are evaluated for IFN side effects, including fever, flu-like symptoms, lethargy, postnasal drip, skin rash, and hair loss. Haematocrit, Haemoglobin, white blood cell and platelet counts, and liver function tests are obtained every 6 weeks (sooner if indicated), and the primary tumor site is monitored by clinical examination and radiography. In cases of neutropenia or thrombocytopenia, the therapy is stopped or dose is reduced. Periodic radiographic assessment is done to monitor assessment of resolution of the lesion. When the defect appears to be filled in with bone on the panoramic radiograph, a confirmatory CT scan is done. The mean duration of treatment was seen to be 7.3 +/- 0.8 months, and no patients exhibited growth of the lesion during the treatment.It is also suggested that Interferon-2α combined with bisphosphonates might further improve the treatment of giant cell lesions[44].

4. Other Emerging Therapies

It has been suggested that immunohistochemical staining for glucocorticoid and calcitonin receptors on the mononuclear or multinucleated cells in giant cell lesions can help in choosing most appropriate conservative, medical therapy[45].

It has also been shown that osteoclastogenesis is under the influence of Osteoprotegrin (Inhibition of bone resorption) and its antagonist osteoprotegrin ligand (Initiation of resorption) via osteoclasts receptor proteins that have been found to be present in CGCG and are known as RANK (Receptor Activator of Nuclear Factor-kB)[46]. Osteoprotegrin as a pharmacologic agent has been proposed to inhibit bone resorption

which makes a similar rationale of use to calcitonin. However, the utility of osteoprotegrin is untested, and the systemic effects have not been evaluated. Other agents such as bisphosphonates and TGF-beta, that are associated with bone metabolism deserve assessment (Not yet tested in giant cell lesions).
The future holds promise for the therapy of CGCG, as with ongoing clinical and laboratory research on focus of gene and protein expression of these tumours can lead to identification of therapeutic targets.

Conclusion

The relatively high frequency of CGCGs in the population makes it important for clinicians to understand their clinico-radiologic presentation and clinical behaviour. Classifying these lesions as 'aggressive' or 'nonaggressive' can help in choosing the most appropriate treatment. We suggest that the 'nonaggressive' counterparts can be managed effectively with conservative surgical approach. However, in cases of 'aggressive' lesions seen more often in a younger population, instead of more morbid surgical procedures, an alternative or adjuvant therapy can be relied upon.

Disclosure

Both the authors declared no competing interest.

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Review Article

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Dental Pulp Stem Cells: A Promising Tool for Regenerative Medicine

Md. Abu Saeed Ibn Harun[1]* Foysal Sirazee[2] Shakawat Tabrej[3] A K M. Shalauddin[4]

Abstract

Background: *Human tissues are different in term of regenerative properties. Stem cells are a promising tool for tissue regeneration, thanks to their particular characteristics of proliferation, differentiation and plasticity. The aims of this review is to underline the state of the art on the dental pulp stem cells research and focus on their clinical potential application for craniofacial tissue engineering.* ***Materials and methods:*** *An initial literature search of database of the search term yield 48 open access full text article. Among those 4 articles were included in this review because of they reported about human and animal studied with follow up.* ***Results:*** *They seem to possess immunoprivileges as they can be grafted into allogenic tissues and seem to exert anti-inflammatory abilities, like many other mesenchymal stem cells and repaired bone defect by bone formation.* ***Conclusion:*** *The easy management of dental pulp stem cells makes them feasible for use in clinical trials on human patients.*

Key words

Stem cells; Dental pulp ;Bone tissue engineering; Tissue repair; Cell therapy.

Introduction

Dental caries, periodontitis, tooth loss, and bone resorption are considered prevalent health problems that have direct affect on the quality of life.While, advances in stem cell biology and biotechnology have sparked hope for devastating maladies, such as diabetes, cardiovascular diseases etc, it also provides a strategy of regenerative therapy for dental tissues[1]. From the prospective of tissue engineering, it is of utmost importance to understand and emulate the complex cell interactions that make up a tissue or organ. Unlike other tissues in the body, dental tissues are unique in their development, function, and even in their maintenance throughout life[2]. Humans, unlike species such as salamander or newt, lack the ability to naturally regenerate their own tissues. To overcome this limitation, tissue engineering strategies utilizing combinations of biocompatible scaffolds, growth factors, and stem cells to mimic natural morphogenesis, are currently in development[3]. In humans, morphogenesis during embryological development relies on the spatial organization of cells to give rise to tissues and organs.While these morphogenetic events are under genetic control, the formation of specialized structures is governed by the microenvironment in which the cells reside.Tissue engineering aims to emulate morphogenesis for the purpose of tissue and organ regeneration, both in the laboratory as well as in situ[4-7]. The overall goal of these strategies is to provide the delivered (as well as surrounding) cells with an environment in which they can proliferate, differentiate, and mature to form the desired structure.

Several research groups have been inspired by the natural architecture and composition of specific organs. This inspiration has led to the design of biomimetic scaffolds aimed at achieving an efficient regenerative process. In addition, novel tissue engineering methodologies such as bio-printing have been used to better control the delivery of growth factors and cells in a three-dimensional environment. These new

1. Associate Professor of Conservative Dentistry and Dental Radiology Chattagram International Dental College Chattogram.
2. Assistant Professor of Conservative Dentistry and Dental Radiology Chattagram International Dental College Chattogram.
3. Senior Lecturer of Conservative Dentistry and Dental Radiology Chattagram International Dental College Chattogram.
4. Associate Professor of Prosthodontics Chattagram International Dental College Chattogram.

*Correspondence to :
Dr. Md. Abu Saeed Ibn Harun
Cell: 01711 15 75 86
Email: drharunpg@yahoo.com

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methodologies aim to leverage developmental biology principles toward the engineering of organs. Such efforts may prove critical for in vitro organ building[8].

Stem cells are generally defined as clonogenic cells capable of both self renewal and multi-lineage differentiation. Post-natal stem cells have been isolated from various tissues, including bone marrow, neural tissue, skin, retina, and dental epithelium[9-11]. Recently, we have identified a population of putative post-natal stem cells in human dental pulp, DPSCs. The most striking feature of DPSCs is their ability to regenerate a dentin-pulp-like complex that is composed of mineralized matrix with tubules lined with odontoblasts, and fibrous tissue containing blood vessels in an arrangement similar to the dentin-pulp complex found in normal human teeth[11].

In this framework, stem cells are a promising tool for tissue repair[6], thanks to their extensive proliferation and differentiation plasticity, characteristics that make them able, theoretically, to regenerate the structure of injured tissues. One of the main problems of the therapeutic use of stem cells remains the identification of accessible siteswithin the human body where collecting an adequate amount of stem cells. Although their number is higherbefore the birth, also within the adult human body there are several “loci” or “niches” inhabited by a significant number of stem cells[12-14].

Dental pulp stem cells have efficiently demonstrated to answer to all these questions due to easy surgical access, the very low morbidity of the anatomical site after the collection of the pulp, the high efficiency of the extraction procedure of the stem cells from the pulp tissue, their differentiation ability, and demonstrated interactivity with biomaterials for tissue engineering applications. The aim of this review is to underline the state of the art on dental pulp stem cells research and focus on their clinical potential application for craniofacial tissue engineering.

Search Strategy

The google scholar database were queried for relevant articles to the topic of dental stem cells in regeneration. The search terms were following key word used in various combination: Dental Pulp, Stem cells, Bone tissue engineering, Tissue repair, Cell therapy. Total 48 open access full text articles were found. But 4 articles were included in this review due to they reported the follow up in human and animal studied. To better delineate between the studies, the article reviewed in our analysis are outline in table I.

Table I : Effects of Dental Stem cells for alveolar bone regeneration.

Authors	Scaffolding Materials	Study model	Results
Hoffmann et al, 2008[27]	high-density polytetrafluoroethylene (dPTFE) membranes without the use of a graft material	Human extraction sockets	The use of dPTFE membranes predictably led to the preservation ofsoft and hard tissue in extraction sites.
Dekok et al 2005[28]	hydroxyapatite/ tricalcium phosphate (HA/TCP) cylinders	Extraction sockets in beagle dogs	Local bone repair occurred in the absence of nonspecific differentiation or migration with distant osteogenesis.
Wikesjö et al, 2008[29]	Titanium implants coated with rhBMP-2	Alveolar ridge defects in dogs	rhBMP-2 coated onto titanium porous oxide implant surfaces induced clinically relevant local bone formation including verticalaugmentation of the alveolar ridge and osseointegration. Higher concentrations/doses were associated with untoward effects.
Serino et al 2008[30]	Bioabsorbable polylactidepolyglycolide acid sponge (Fisiografts)	Human extraction sockets	The bone formed 3 months after the extraction was rich in osteoblasts and newly formed blood vessels. The biocompatibility, safety, and characteristics of Fisiografts suggest that the material is suitable for filling alveolar sockets following extractions, to prevent volume reduction and collapse of the overlying soft tissue flaps.

DPSCs and Bone Regeneration

The need for bone is increasing in western countries in the past few decades as result of the large increase of age of the average population. In the elderly, fractures

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tend to occur more frequently because of bone weakening due to a decrease in calcium content in extra cellular matrix and slowing of bone remodeling mechanisms[15]. In addition, the periostium and the bone marrow stromal fraction are rich of bone progenitors, so that the bone, since early 90s, has been one of the approachable goals of clinical tissue engineering.

Dental pulp stem cells showed differentiation profiles similar to those showed during bone differentiationand this event make them very interesting as a model to study the osteogenesisand the relationship with scaffolds[16,17]. Laino and colleagues demonstrated that SBP-DPSCs, when undergo their differentiation to preosteoblasts, deposit an extracellular matrix which becomes a calcified woven bone tissue called LAB (Living autologous bone). The LAB can be produced already in vitro on 3D pre-carved scaffold[18]. Today in vitro bone regeneration studies are limited by the main difficulty to obtain a cytotype capable of forming a complete tissue and not only a monolayer of cells surrounded by a mineralized matrix. Due to their high proliferation rate and efficiency in producing bone chips, DPSCs seem to be the best candidates to study bone formation with respect to Bone Marrow Stem Cells (BMSCs) whose efficiency is limited by the fact that they differentiate into osteoblasts and produce small calcified nodule, but not chips of bone tissue. In this way in pre-clinical phase it is possible to assess the osteoconductivity of a biomaterial. Moreover, a complete differentiation with subsequent tissue formation, including an adequate blood supply is of paramount importance for tissue repair and transplantation. In addition, it has been shown that no differences were found when comparing stem cells and differentiated cells obtained from young (Up to 29 years) and old (30– 45 years) subjects, regarding their expansion rate and number of calcification centers and LAB nodules obtained per well[19]. This make the LAB a promising tool not only to study the bone regeneration but as therapeutic tool. Therefore, these cells appear to be good candidates for bone-tissue reconstruction protocols and bone regeneration models, thanks to the high BMP-2 and VEGF secretion and cellular morphology[20]. Transplantation results obtained with SBP-DPSCs are of extreme interest for therapeutic use. In fact, both woven chips and stem cells challenged with a scaffold, after transplantation, become adult bone, with a complete vascularization, of human origin, containing host blood. These results demonstrate that chips obtained in vitro, as well as cells, become adult bone tissue when transplanted into immunosuppressed rats. In addition, the dimension of the obtained bone are the same of the grafted chips or of the scaffolds and that bone differentiation and maturation is almost complete, as an evident and functionally efficient vascularization takes place. In particular, complete Haver's channels containing blood vessels and surrounded by bone arranged in a lamellar configuration have been obtained. On the other hand, this study of the osteoblast genesis led to the challenge of managing the bone differentiation stimulating quiescent progenitors resident in the tissue itself. The advantage of this approach is the use of autologous pre-committed cells, decreasing the dangers of ex-vivo stimulation. Therefore, DPSCs may be a good standard to study the ossification process along substrates suitable for clinical application in bone reconstructionas assessed in experiments performed challenging the stem cells and scaffolds, both in vitro and in vivo[20-22].

Current Promising Application Alveolar Bone Regenerations

Current scientific effort seeks to solve the still problematic treatment of large bony defects in oral and craniomaxillofacial surgery prior to oral rehabilitation. These defects remain serious problem as the associated loss of function and esthetic considerably impairs the quality of life of the affected patient. The existed techniques do in general result in a favorable clinical outcome, but it is associated with undeniable drawbacks such as a considerable increase in surgical procedures, as well as elevate postoperative morbidity to the patient and connectedly high costs to the socio-economic system[23,24].

Since the introduction of tissue engineering into the scientific community 20 years ago, several efforts have been undertaken to transfer the technology from research to beside. Alveolar bone defects resulting from tooth loss, trauma, congenital abnormalities, progressive deforming diseases or oncological resection, present a formidable challenge and restoration of these is a subject of clinical, basic science, and engineering concern[25,26]. There are several locations in the oral/craniofacial region where repair, regeneration of alveolar bone is vital, e.g. the alveolar defect results from extraction of the tooth. In this condition, regeneration of this defect usually results in preservation of the remaining buccal and lingual walls of the socket. This wound should regenerate alveolar bone till the crestal level of the remaining socket walls, so the end result is alveolar ridge that can receive dental implant and preserve the distance between the two

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neighboring teeth to the extracted socket and prevent these neighboring teeth from tilting and reduce the existed space for rehabilitation[27-30].

Tissue Engineering of the Periodontal Tissue

The mechanistic understanding of the molecular and cellular pathways of cell differentiation resulting in tissue induction and morphogenesis is central to tissue engineering and morphogenesis. The induction of bone formation, after the classic studies of 'Bone: Formation by autoinduction', has set into motion the ripple-like cascade of tissue induction and morphogenesis including the induction of the complex tissue morphologies of the periodontal tissues, i.e., the avascular cementum attached to the dentinal root surface, the alveolar bone and the periodontal ligament fibers uniting the alveolar bone to the root cementum penetrating the cementum as mineralized Sharpey's fibers[31,32]. The induction of bone formation and the induction of periodontal tissue regeneration require three key components: a soluble osteogenic molecular signal, an insoluble signal or substratum that delivers the osteogenic signal and acts as a scaffold for the induction of bone formation, and responding stem cells capable of differentiation into selected cellular phenotypes after transmembrane serine-threonine kinase receptors' activation and phosphorilation ultimately leading to tissue induction and morphogenesis.

Dynamics for Pulp-Dentin Tissue Engineering in Operative Dentistry

In 1997, Michael Barnett wrote that *"when I consider the mode of dental practice we learned in dentalschools 30 years ago and compare it with today's practice, I see great process but not a quantum leap.Workcurrently underway suggests that a quantum leap is possible and is, in fact, achieavable. Those individualslucky enough to be practicing well into the 21st century will have the opportunity to utilize the fruits ofcurrent research".* The challenge of the today dental research is to integrate advanced biological knowledgeinto the clinical approach to the problems of dental practice. Especially, an advance in molecular biology and bioengineering research is now integrated into the clinical problems of dentistry. Ourbasic concepts on biological mechanisms underlying the development, function, and regenerationpotential of the dental tissues, more particularly of the skeletal body of the tooth named pulp-dentincomplex, have already opened new directions to the scientists to devise more realistic therapeutic strategies for the treatment of the dental diseases.

It has been repeatedly demonstrated that odontoblast terminal differentiation can only occur under epigenetic signals, given by stage-specific inner dental epithelium and basement membrane or by substituting network of matrix molecules and growth factors. Matrix molecules, growth factors, transcription factors and their specific receptors have shown to represent a network of molecular mechanisms leading peripheral papilla ectomesenchymal cells to express their competence, the odontoblast phenotype[33-37].Preodontoblasts, which were mechanically dissociated from the inner epithelium after their last mitosis, became fully differentiated cells only in association with the basement membrane. Odontoblast polarization and initiation of predentin secretion might require specific structural and compositional organization of the matrix in the basement membrane; it appears that trapped molecules rather than permanent components of the basal lamina play the crucial role[38].

The Process of Odontoblast Differentiation has been Ddesrcibed as a Cascade of 3 Cytological steps

i) Cessation of cell division. Odontoblasts are postmitotic cells incapable of further cell division[39,40]. During the last mitosis of preodontoblasts, the mitotic spindle lies perpedicular to the basement membrane[41]. Daughter cells in close proximity to the basement membrane become odontoblasts apical cells, named Holl's cells, constitute a layer of potential preodontoblastic cell lineage, giving rise to replacement odontoblast-like cells[42].

ii) Cell polarization. The peripheral post-mitotic preodontoblasts become larger and elongate, their nuclei take up a position in the apical part of the cell body and a trunk of cytoplasmic processes is formed.The cisternae of the granular endoplasmic reticulum progressively become parallel to the long axis of the cells.Further enlargement of Golgi region, specific modifications of the plasma membrane and cytoskeletal rearrangement characterize odontoblast polarization at the ultrastructural level[43].

iii) Predentin formation. Polarized cells synthesize and secrete extracellular matrix in a polarpattern. Secretion of predentin around the odontoblastic process gives a tubular appearance inthe forming matrix.

Cryopreservation of DPSCs

Cryopreservation of cells and tissue, mainly of the reproductive system, has been significantly improved lately, but up to now only hematopoietic stem cells have been cryopreserved and then successfully utilized for

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transplantation. Moreover, dental pulp represents an easily accessible source of stem cells that can be cryostored for long periods and used to establish a cryobank for adult tissue regeneration[44]. Dental pulp stem cells retain their potential after cryopreservation, as observed by Zhang[45]. Therefore, the group of Laino and Papaccio undertook to observe the ability of SBP-DPSCs, and of their derived osteoblasts, to be cryopreserved and recovered after a 2-year period. This study provides evidence that dental pulp stem cells and their differentiated osteoblasts can be easily cryopreserved and recovered. This renders them a potentially useful and reliable source of cells for delayed therapies, designed for tissue repair upon patients' needs. After long-term cryopreservation, osteoblasts differentiated from SBP-DPSCs, are still capable of quickly restarting proliferation and the production of mineralized matrix, in a manner similar to what we have already demonstrated for fresh cells[46]. Furthermore, proliferation was comparable to that of fresh cells, with no apoptotic cell death. In addition, cells were found to retain their multipotency, all which is of interest when assessing the suitability of stem cells for use after cryopreservation. Moreover, osteoblasts produced a large-scale woven bone, which we observed in at least 100 25 cm2 flasks. Samples of this bone, when transplanted into immunosuppressed rats, were remodelled into lamellar bone, further demonstrating their vitality. A study was performed on cryopreserved tissue samples of minced periodontal ligament. Cryopreservation of whole dental pulp does lead to safe recovery. Different cryopreservation techniques are probably required for whole pulp. These features and abilities make these cells attractive for therapeutic three-dimensional tissue reconstruction, with the potential of tailoring storage and recovery to the needs of the patient.

Conclusion

The extreme feasibility to manage the dental pulp stem cells make them ready to use in clinical trial on human patients: autologous stem cells collected from dental pulp of extracted wisdom teeth or from pulpectomy of teeth left in situ is a chance that should be improved in clinical trial. In this field supposed immunosuppressive activity of the dental pulp stem cells, if confirmed, it would be of extremely importance. Although in the future dental pulp could play a fundamental role in all human tissues regeneration. The main commitment is bone and bone regeneration is the goal where these cells can find an immediate applications.

Disclosure

All the authors declared no competing interest.

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206/1, Haji Chand Meah Road, Shamserpara, Chandgaon, Chattogram, Bangladesh.
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