Knowledge About Cellular Regeneration - A Survey Among Undergraduate Dental Students

S. Bhavesh[1] , Dr. Palati Sindhuja[2] , Dr. Suganya P[3]

[1]Saveetha Dental College And Hospitals, Saveetha Institute Of Medical And Technical Sciences (SIMATS), Saveetha University, Email Id: 152001035.Sdc@Saveetha.Com

[2]Senior Lecturer, Department Of Pathology, Saveetha Dental College And Hospitals, Saveetha Institute Of Medical And Technical Sciences (SIMATS), Saveetha University
Email Id: Sindujap.Sdc@Saveetha.Com +91 9600141020

[3]Senior Lecturer, Department Of Oral Pathology, Saveetha Dental College And Hospitals, Saveetha Institute Of Medical And Technical Sciences (SIMATS), Saveetha University, Email Id: Suganyap.Sdc@Saveetha.Com + 91 9500905713

ABSTRACT:

Aim: The main aim of the study is to conduct a survey on knowledge and awareness about cellular regeneration among undergraduate dental students.

Background: Regeneration involves the capacity for renewal of tissues, organs or even organisms, after considerable physical injury or damage, resulting from pathologies, tumors, congenital diseases. As a sequence of tissue regeneration the properties of the new tissues are highly similar to the newly formed tissues.

Materials and Methods: The present cross sectional study was conducted among 102 random dental students in a Private dental college. An online e-questionnaire was prepared and the responses were collected and analysed by descriptive statistical analysis in SPSS software version 23.

Results: In the present study, responses of males were 68 and females were 34 and nearly 55% of the population were not aware of cellular regeneration and its techniques with the p value 0.074 which is not significant. The 1st year dental students have more knowledge on cellular regeneration than the other year students.

Conclusion: According to the results observed in this study, most of the dental students have adequate knowledge on cellular regeneration thus showing interest in the concerned subject. It would be a great change if the students get more opportunities to know the recent advances of cellular regeneration as well.

Keywords: Cellular regeneration, innovative method, stem cell, liver, skin, innovative technique.

INTRODUCTION:

Regeneration in humans is the regrowth of misplaced tissues or organs in reaction to damage. This is an assessment to wound healing, or partial regeneration, which includes last up the damage, with a few gradation of scar tissue. Some tissues which include skin, the vas deferens, and huge organs consisting of the liver can regrow pretty readily, at the same time as others had been notion to have very little capability for regeneration following any damage (1).

There are diverse strategies which can result in regeneration and it is one of the most important innovative methods established in current science. By 2016, regeneration of tissue was caused and operationalized with the aid of the usage of 4 principal strategies: regeneration with the aid of using instruments;regeneration with the aid of materials ;regeneration with the aid of drugs and regeneration with the aid of using in vitro 3d printing (2). Skin tissue may be regenerated in vivo, and in vitro. Other organs and frame elements which have been procured to regenerate include: penis, fats, vagina, mind tissue, thymus, and a scaled down human heart.

The regenerative capacity is directly related to the presence of stem cells (or) progenitor cell, which are more capable of proliferation and differentiation (3)(4).Tissues maintain a high proliferative capacity, as hematopoietic systems, which have the regenerative capacity even in adult organisms(5). Cell proliferation is a repair process in general, which is accompanied by production of extracellular matrix, large amounts of collagen, and fibrous tissue to occupy the injured area. The final stage of cell regeneration is cell differentiation which is a critical process. Understanding these processes requires advanced technologies which will be processed in future(6). It is mandatory for the dental students to know about cellular regeneration as they apply this technique in various dental procedures like implant, rct, bonding.Our team has extensive knowledge and research experience that has translated into high quality publications (7-26). The main aim of the study is to assess the knowledge about cellular regeneration among undergraduate dental students.

MATERIALS AND METHODS:

The study was based on a cross sectional survey with random sampling with a population of 102 participants of the general population from outpatients of a private dental college at Chennai. Each of the participants completed a self administered, anonymous survey study consisting of online questionnaires that are self prepared. It also included few demographic details (age and gender) and few questions related to cellular regeneration. This was a pre-validated questionnaire. The subjects received a study invitation by email containing a link to the questionnaire. The online survey was conducted during the first week of February. They were approached by different recruitment strategies. Informed consent was collected from the respondents who agreed to participate in the

study. Chi square test was used to analyze and comparative bar graphs were plotted and it is statistically significant only if the p value is less than 0.05.

S.No	Question	Option 1	Option 2	Option 3
1	Age			
2	Gender	Male	Female	
3	Do you know what is cellular regeneration	Yes	No	
4	Do you know any recent discovery in cellular regeneration	Yes	No	
5	Do you know that cellular regeneration can be done in humans apart from animals	Yes	No	Maybe
6	Do you know the various methods of cellular regeneration	Yes	No	Maybe
7	Which tissues have the property of regeneration	Epidermal tissues	Epithelial tissues	Striated tissues

| 8	Which human organ undergoes fastest regeneration	Spleen	Liver	Pancreas
9	How many days once does the skin regenerate	10 days once	27 days once	Never
10	Which cells has shortest life span	Neutrophils	Basophils	Lymphocytes
11	Which vitamin intake is required for faster skin regeneration	Vitamin B	Vitamin C	Vitamin D

RESULTS:

In the present study, 68 were male participants and female participants were 34. In our study, 69.31% of the participants have an idea of cellular regeneration whereas 30.69% of the participants have no idea on cellular regeneration (**Fig 1**). In our present study, 38.61% of the participants have idea on recent advances in cellular regeneration whereas 61.39% of the participants have no idea on recent advances in cellular regeneration (**Fig 2**). Also, 34.65% of the participants know that cellular regeneration can be done in humans whereas 40.59% of the participants don't know that cellular regeneration can be done in humans (**Fig 3**). In our study, 33.66% of the participants have an idea on the various methods of cellular regeneration (**Fig 4**) and 48.51% of the participants know that epithelial tissues have the property of regeneration (**Fig 5**). Also, 68.32% of the participants know that the liver regenerates fast (**Fig 6**) and 63.37% of the participants think that skin regenerates 27 days once whereas 25.74% participants think that skin regenerates 10 days once and 10.89% think that skin never regenerates (**Fig 7**). Regarding Neutrophils, 42.57% of the participants think that

neutrophils have a shorter life span, (**Fig 8**) and also 63.37% of the participants think Vitamin C is required for faster skin regeneration (**Fig 9**). Males were aware of the subject more than females. Pearson chi square test was used to determine the relationship between gender and responses for the question regarding cellular regeneration in humans and p value is 0.074, (p value > 0.05). Hence, it is statistically not significant (**Fig 10**). Majority of the responses were on epithelial tissues. 15.84% of the females and 32.67% of the males responded for "epithelial tissues" and p value is 0.398, (p value > 0.05). Hence, it is statistically not significant.(**Fig 11**). Pearson chi square test was used to determine the relationship between year of study and responses for the question regarding methods of cellular regeneration and p value is 0.344, (p value > 0.05). Hence, it is statistically not significant.(**Fig 12**). Majority (9.9%) of the 1st year students were aware of the methods of cellular regeneration, while in 2nd year (5.90%) were aware and in 4th year (3.9%) were aware of the different methods of cellular regeneration. According to the above study, the first year dental students have more knowledge on cellular regeneration than the other year students and males have more awareness on the topic cellular regeneration than females.

The association between the gender and response for the question regarding epithelial tissue was evaluated using pearson chi-square test and the results were tabulated as bar graphs with a p-value of 0.398. Hence, it is statistically not significant. The association between the year of study and response for the question regarding methods of cellular regeneration was evaluated using Pearson Chi- Square test and the results were tabulated as bar graphs with p-value of 0.344. Hence, it is statistically not significant.
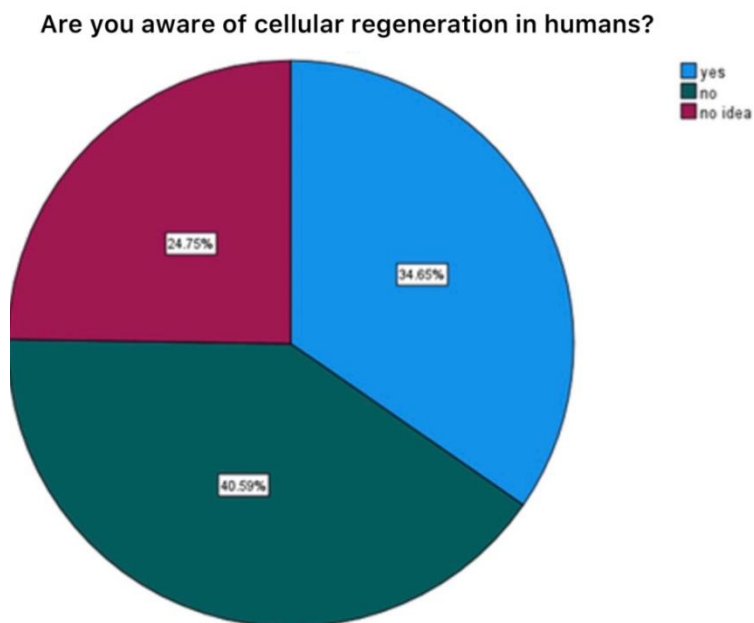

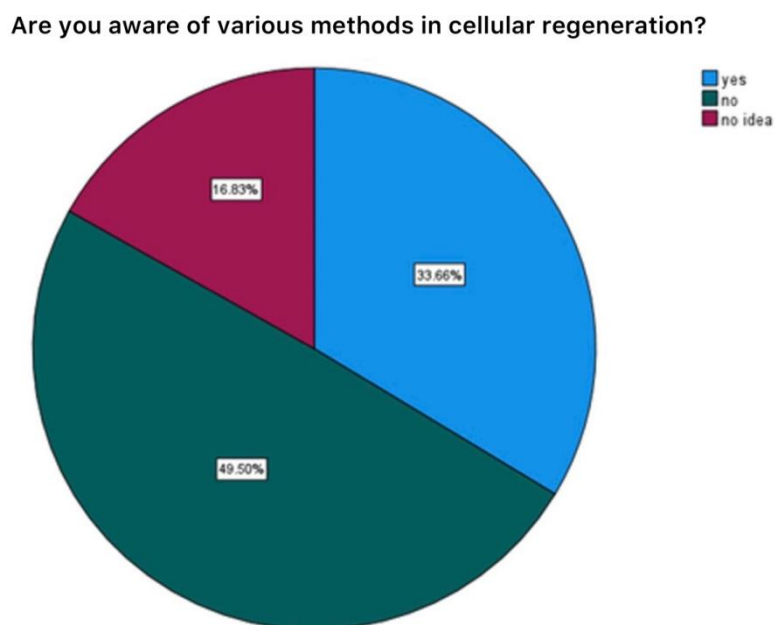Do you know about cellular regeneration?
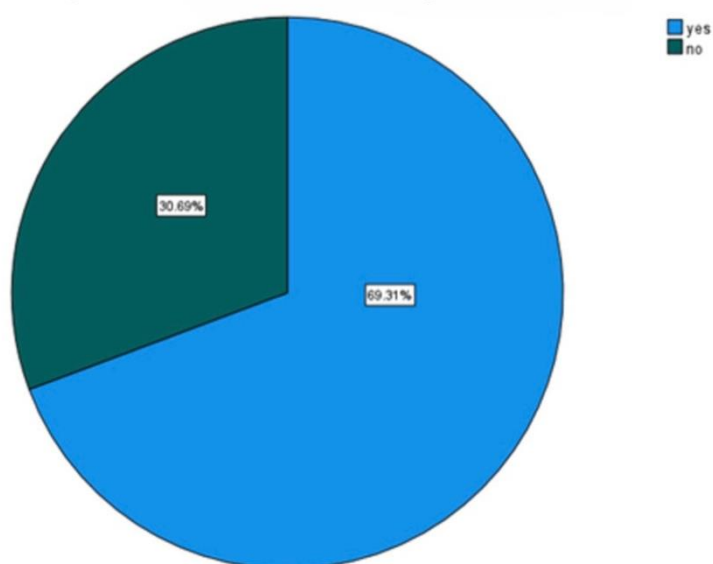
Figure 1: Shows the responses of participants for the question regarding the idea of cellular regeneration. Blue indicates "Yes" and Green indicates "No". Majority of the participants have an idea of cellular regeneration,only 30.69% of the participants do not have an idea on cellular regeneration.

Are you aware of recent advances in cellular regeneration?
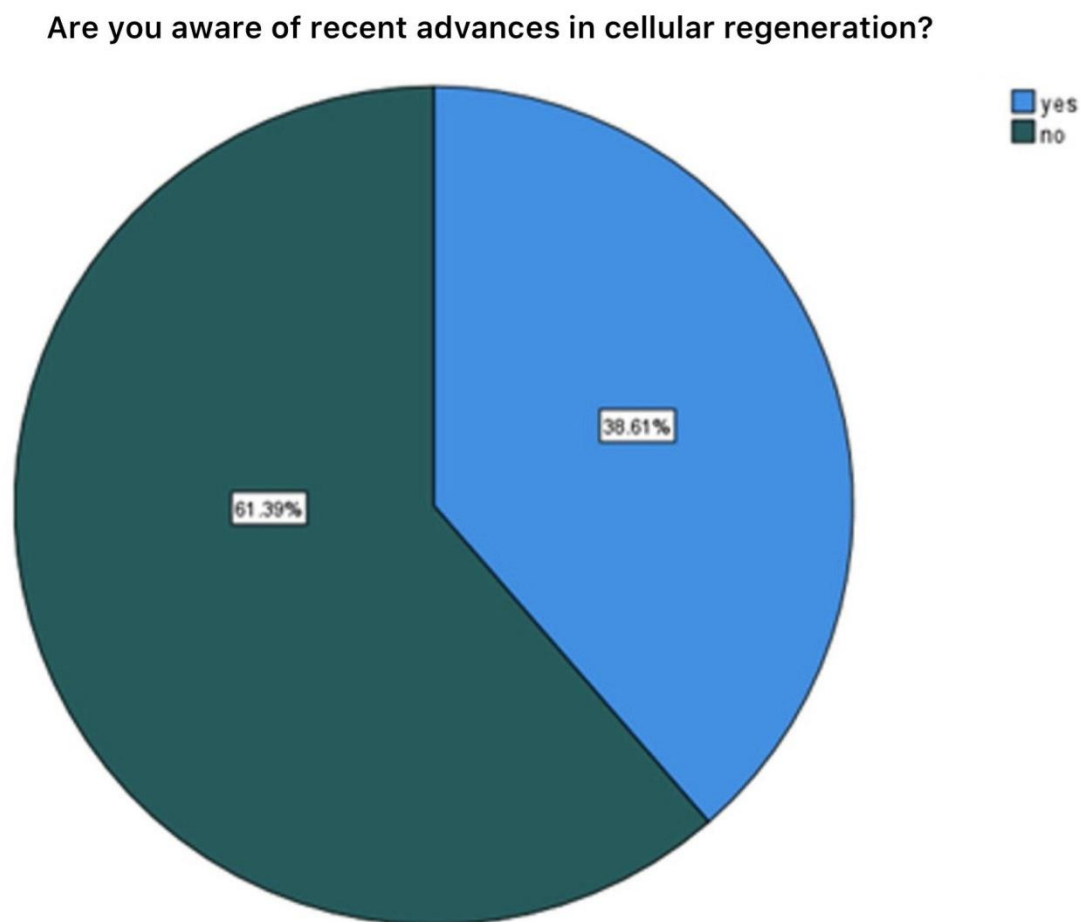
Figure 2: Shows the responses for recent advances in cellular regeneration. Blue indicates "yes", Green indicates "no". Majority of the participants do not have an idea on the recent discovery on cellular regeneration whereas 38.61% of the participants have an idea on the recent discovery on cellular regeneration.

Are you aware of cellular regeneration in humans?

Figure 3 shows the responses for cellular regeneration in humans . Blue indicates "yes", Green indicates "no", Purple indicates "no idea". Majority(40.59%) of the participants do not have an idea on cellular regeneration in humans.

Are you aware of various methods in cellular regeneration?

Figure 4 shows the responses for various methods in cellular regeneration. Blue indicates "yes", Green indicates "no", Purple indicates "no idea". Majority(49.50%) of the participants don't know the methods of cellular regeneration but they know about cellular regeneration ,whereas 33.66% have ideas on the methods of cellular regeneration.
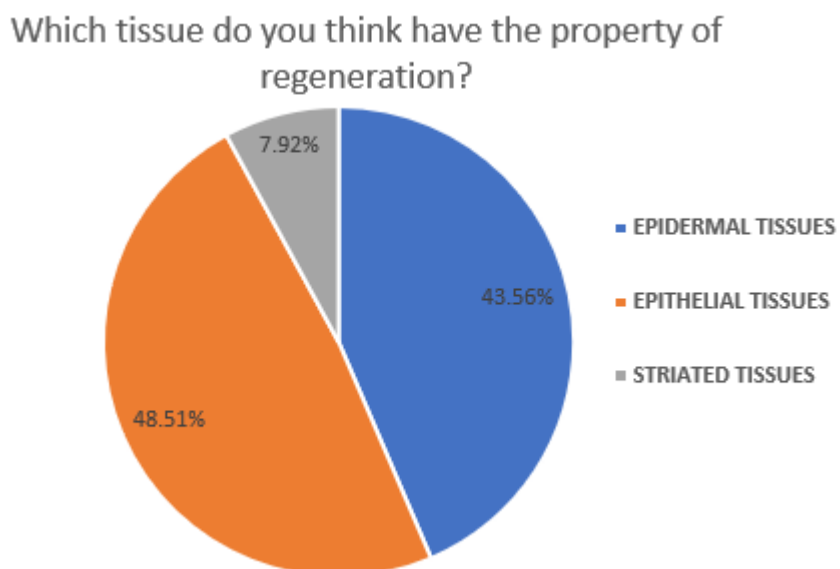
Figure 5: Shows the response for tissues which have the property of regeneration.Violet indicates "epidermal tissues", Orange indicates "epithelial tissues". Grey indicates "striated tissues". Majority(48.51%) of the participants think that epithelial tissues have the property of regeneration.
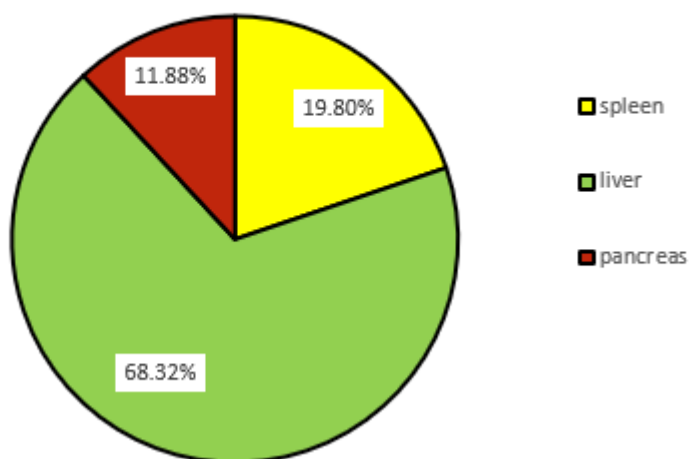

Figure 6: Shows the responses for human organs undergoing fastest regeneration'.Yellow indicates "spleen", Light green indicates "liver", Maroon indicates "pancreas". Majority(68.32%) of the participants think that the liver undergoes fastest regeneration whereas 19.80% of the students think that the spleen undergoes fastest regeneration and 11.86% of the students think that the pancreas undergoes fastest regeneration.

## Are you aware in how many days once the skin regenerates?
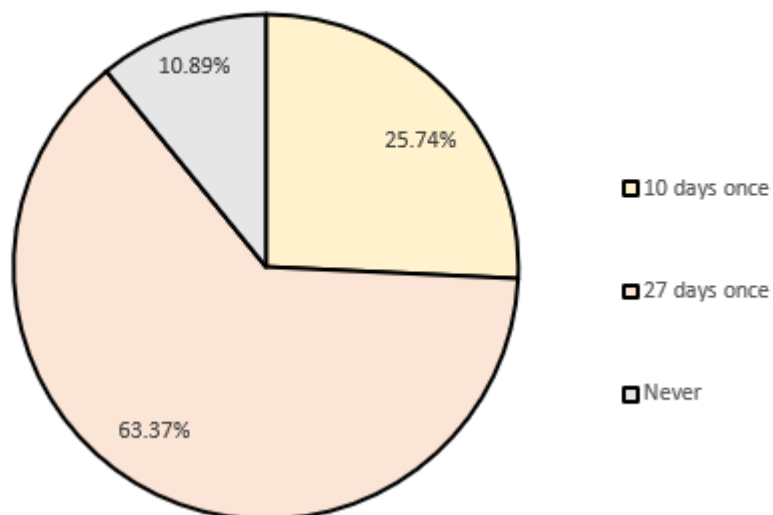
Figure 7: Shows the response for within how many days the skin regenerates. Peach indicates "27 days once", Gold indicates "10 days once", Silver indicates "never". Majority(63.37%)of the participants think that skin regenerates 27 days once whereas 25.74% participants think that skin regenerates 10 days once and 10.89% think that skin never regenerates.

## Are you aware which cell has the shortest life span?
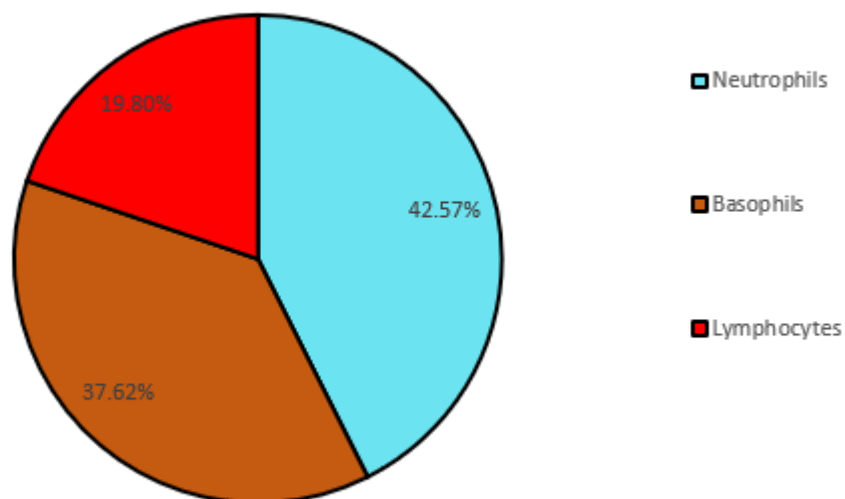
Figure 8: Shows the response for cells with the shortest life span. Aqua indicates "Neutrophils", Brown indicates "Basophils", Red indicates "Lymphocytes". Majority

(42.57%) of the participants think that neutrophils have a shorter life span.

## Are you aware which vitamin is required for skin regeneration?
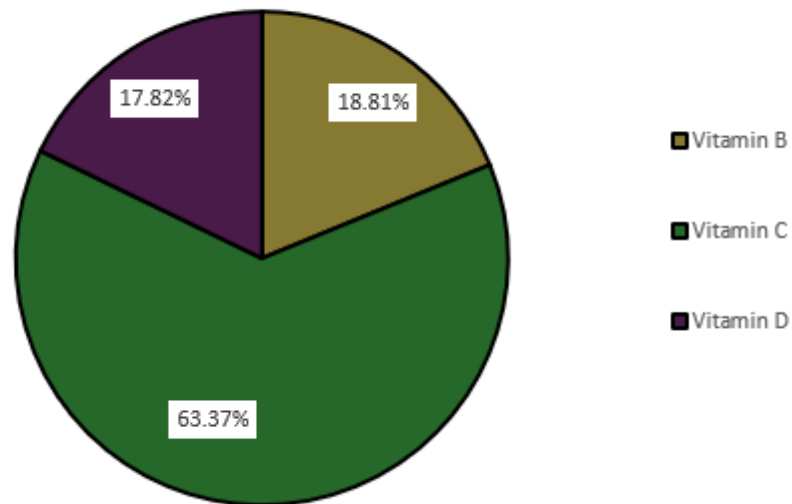
Figure 9: Shows the response for vitamins required for faster skin regeneration. Blue indicates "Vitamin B", Green indicates "Vitamin C", Purple indicates "Vitamin D". Majority(63.37%) of the participants think Vitamin C is required for faster skin regeneration.

.
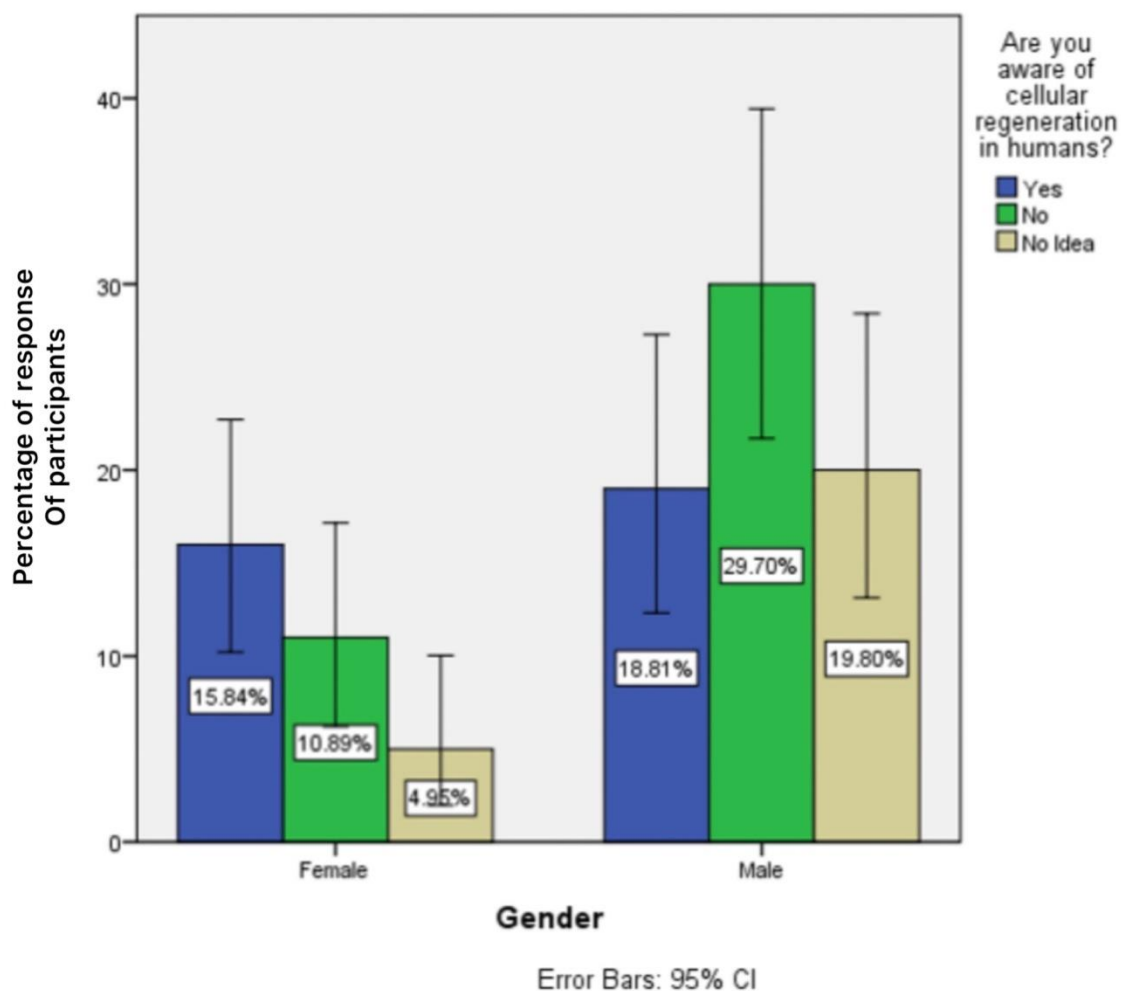
Figure 10: The bar graph represents the association between gender and responses for the question regarding cellular regeneration in humans. X axis represents the gender and Y axis represents the percentage of responses from the participants. Blue indicates "Yes", Green denotes "No", Sandal denotes "no idea". Males (18.81%) were aware of the subject more than females (10.89%). Pearson chi square test shows p value is 0.074, (p value > 0.05). Hence, it is statistically not significant.
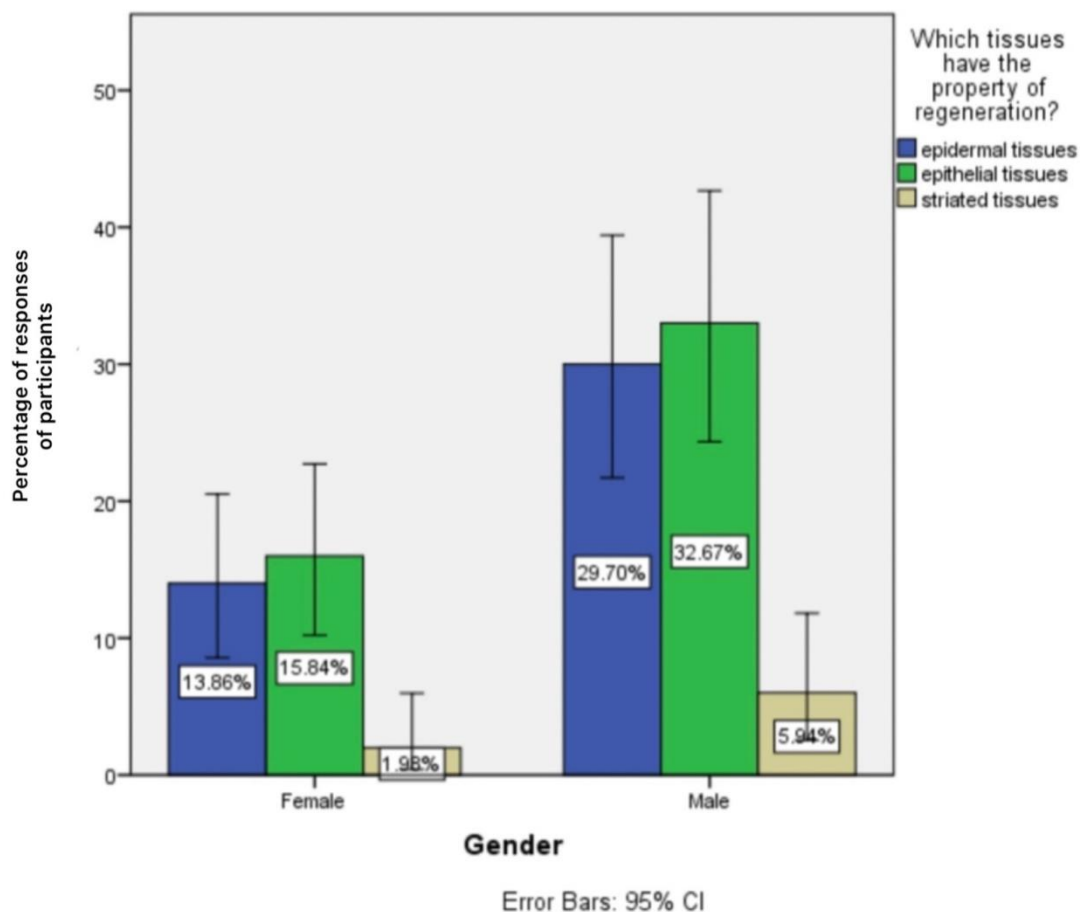
 Figure 11: The bar graph represents the association between gender and responses for the question regarding tissues with property cellular regeneration. X axis represents the gender and Y axis represents the percentage of responses from the participants. Blue denotes "epidermal tissues", Green denotes "epithelial tissues", Sandal denotes "striated tissues". Majority of the responses were on epithelial tissues. 15.84% of the females and 32.67% of the males responded for "epithelial tissues". Pearson chi square test shows p value is 0.398, (p value > 0.05). Hence, it is statistically not significant.
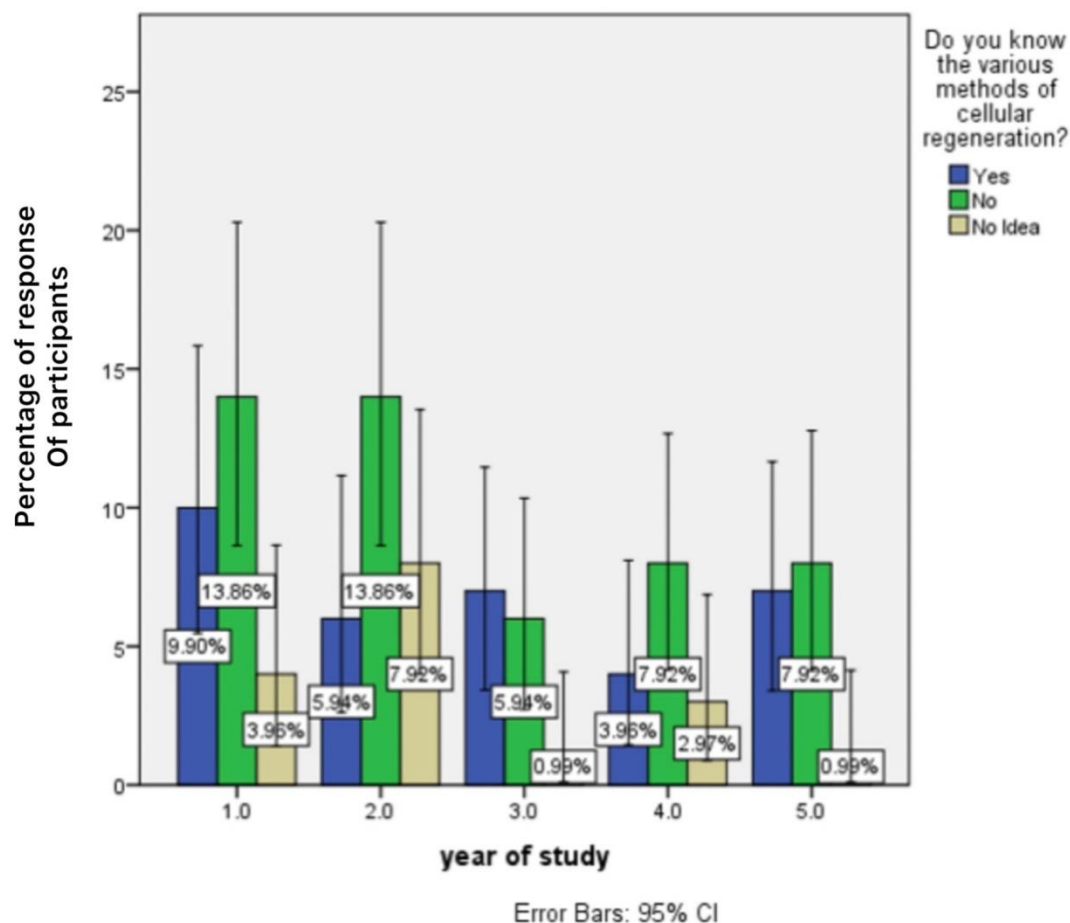
Figure 12: The bar graph represents the association between year of study and responses for the question regarding methods of cellular regeneration. X axis represents the year of study and Y axis represents the percentage of responses from the participants. Blue denotes "Yes", Green denotes "No" , Sandal denotes "No idea". The first year dental students (9.9%) have more knowledge on cellular regeneration than the other year students. Pearson chi square test shows p value is 0.344, (p value > 0.05). Hence, it is statistically not significant.

DISCUSSION:

According to the above study, the first year dental students have more knowledge on cellular regeneration than the other year students and males have more awareness on the topic cellular regeneration than females. From the above study, we can say that 69.31% of the participants have an idea of cellular regeneration. 33.66% of the participants have an idea on the various methods of cellular regeneration and 48.51% of the participants know that epithelial tissues have the property of regeneration. Also, 68.32% of the participants know that the liver regenerates fast and 63.37% of

the participants think that skin regenerates 27 days once whereas 25.74% participants think that skin regenerates 10 days once and 10.89% think that skin never regenerates. 42.57% of the participants think that neutrophils have a shorter life span,and also 63.37% of the participants think Vitamin C is required for faster skin regeneration

Regeneration of complex structures after injury requires dramatic changes in cellular behavior. Regenerating tissues initiate a program that includes diverse processes such as wound healing, cell death, dedifferentiation, and stem (or progenitor) cell proliferation; furthermore, newly regenerated tissues must integrate polarity and positional identity cues with preexisting body structures. Because of the self-renewing and differentiating properties of its resident stem cells, the human body constantly regenerates after damage. Scientific research in the field of regenerative medicine is actively striving to understand the molecular pathways through which the regenerative potential of stem cells can be turned into a therapeutic application in order to heal damaged tissues and rebuild functional organs(27). In the present study it was observed the majority of the population know what cellular regeneration is, but they don't have enough knowledge on the topic which is needed for further studies.

In the previous studies it was observed that liver regeneration is an essential component of the regenerative process(28). In the present study, 68.32% of the participants were aware about the tissues undergoing fastest regeneration. It also requires more advanced technologies which may be further assessed in the future(4).

Skin is the largest organ of the body, which meets the environment most directly. Thus, the skin is vulnerable to various damages, particularly burn injury. Skin wound healing is a serious interaction between cell types, cytokines, mediators, the neurovascular system, and matrix remodeling. In the previous study, it was concluded that skin regenerates from any kind of injuries within 27 days and the majority of the population were aware of the skin regeneration in the present study as well(9).

Neutrophils (also known as polymorphonuclear leukocytes or PMNs) are the most common white blood cells in humans and play an important role in innate host defence. The short lifespan of PMNs is another unique trait.In the previous study, it was concluded that neutrophils survive for only 24 hours, and also in the present study, most of the students were aware about lifespan of neutrophils.

The research on the stem cells is the currently ongoing project in many research centers and the reason for failures in regeneration in few animals is still uncertain. In this study, we observed the knowledge about cellular regeneration among UG dental students. Most of the UG dental students have adequate knowledge on cellular regeneration and the various methods used for cellular

regeneration. Since the study was a cross sectional and the selection of samples were random sampling, performed amongst Private Dental College, it does not represent the entire population. The study can help to increase awareness about cellular regeneration and the various methods of cellular regeneration, and the importance of science among the dental students.

CONCLUSION:

The goal of regenerative medicine is to restore the damaged cells, tissues and structures. And only the first year students were more aware about cellular regeneration according to our study. Since most of the dental students were not aware about cellular regeneration, more awareness should be created among all the dental students by conducting various seminars, conferences and involving them in research projects on the topic studied.

CONFLICT OF INTEREST:

All the authors declare that there was no conflict of interest in the present study.

REFERENCES:

1. Tam J, Wang Y, Vuong LN, Fisher JM, Farinelli WA, Anderson RR. Reconstitution of full-thickness skin by microcolumn grafting. J Tissue Eng Regen Med. 2017 Oct;11(10):2796–805.

2. Atala A, Lanza R, Thomson JA, Nerem R. Principles of Regenerative Medicine. Academic Press; 2010. 1202 p.

3. Yannas IV. Regeneration of Skin [Internet]. Tissue and Organ Regeneration in Adults. 2015. p.

89–136. Available from: http://dx.doi.org/10.1007/978-1-4939-1865-2_5

4. Tanaka EM, Reddien PW. The Cellular Basis for Animal Regeneration [Internet]. Vol. 21, Developmental Cell. 2011. p. 172–85. Available from: http://dx.doi.org/10.1016/j.devcel.2011.06.016

5. N A, Anoop N. Tissue Repair, Regeneration, Healing and Fibrosis [Internet]. Synopsis of Pathology. 2013. p. 18–18. Available from: http://dx.doi.org/10.5005/jp/books/11992_3

6. Spindler KP. Management of Articular Cartilage Defects of the Knee. 2002. 53 p.

7. Princeton B, Santhakumar P, Prathap L. Awareness on Preventive Measures taken by Health Care Professionals Attending COVID-19 Patients among Dental Students. Eur J Dent. 2020 Dec;14(S 01):S105–9.

8. Mathew MG, Samuel SR, Soni AJ, Roopa KB. Evaluation of adhesion of Streptococcus mutans, plaque accumulation on zirconia and stainless steel crowns, and surrounding gingival inflammation in primary molars: randomized controlled trial. Clin Oral Investig. 2020 Sep;24(9):3275–80.

9. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. J Oral Pathol Med. 2019 Apr;48(4):299–306.

10. R H, Hannah R, Ramani P, Ramanathan A, Jancy MR, Gheena S, et al. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene [Internet]. Vol. 130, Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2020. p. 306–12. Available from: http://dx.doi.org/10.1016/j.oooo.2020.06.021

11. Antony JVM, Ramani P, Ramasubramanian A, Sukumaran G. Particle size penetration rate and effects of smoke and smokeless tobacco products - An invitro analysis. Heliyon. 2021 Mar 1;7(3):e06455.

12. Sarode SC, Gondivkar S, Sarode GS, Gadbail A, Yuwanati M. Hybrid oral potentially malignant disorder: A neglected fact in oral submucous fibrosis. Oral Oncol. 2021 Jun 16;105390.

13. Hannah R, Ramani P, WM Tilakaratne, Sukumaran G, Ramasubramanian A, Krishnan RP. Author response for "Critical appraisal of different triggering pathways for the pathobiology of pemphigus vulgaris—A review" [Internet]. Wiley; 2021. Available from: https://publons.com/publon/47643844

14. Chandrasekar R, Chandrasekhar S, Sundari KKS, Ravi P. Development and validation of a formula for objective assessment of cervical vertebral bone age. Prog Orthod. 2020 Oct 12;21(1):38.

15. Subramanyam D, Gurunathan D, Gaayathri R, Vishnu Priya V. Comparative evaluation of salivary malondialdehyde levels as a marker of lipid peroxidation in early childhood caries. Eur J Dent. 2018 Jan;12(1):67–70.

16. Jeevanandan G, Thomas E. Volumetric analysis of hand, reciprocating and rotary instrumentation techniques in primary molars using spiral computed tomography: An in vitro comparative study. Eur J Dent. 2018 Jan;12(1):21–6.

17. Ponnulakshmi R, Shyamaladevi B, Vijayalakshmi P, Selvaraj J. In silico and in vivo analysis to identify the antidiabetic activity of beta sitosterol in adipose tissue of high fat diet and sucrose induced type-2 diabetic experimental rats. Toxicol Mech Methods. 2019 May;29(4):276–90.

18. Sundaram R, Nandhakumar E, Haseena Banu H. Hesperidin, a citrus flavonoid ameliorates hyperglycemia by regulating key enzymes of carbohydrate metabolism in streptozotocin-induced diabetic rats. Toxicol Mech Methods. 2019 Nov;29(9):644–53.

19. Alsawalha M, Rao CV, Al-Subaie AM, Haque SKM, Veeraraghavan VP, Surapaneni KM. Novel mathematical modelling of Saudi Arabian natural diatomite clay. Mater Res Express. 2019 Sep 4;6(10):105531.

20. Yu J, Li M, Zhan D, Shi C, Fang L, Ban C, et al. Inhibitory effects of triterpenoid betulin on inflammatory mediators inducible nitric oxide synthase, cyclooxygenase-2, tumor necrosis factor-alpha, interleukin-6, and proliferating cell nuclear antigen in 1, 2-dimethylhydrazine-induced rat colon carcinogenesis. Pharmacogn Mag. 2020;16(72):836.

21. Shree KH, Hema Shree K, Ramani P, Herald Sherlin, Sukumaran G, Jeyaraj G, et al. Saliva as a Diagnostic Tool in Oral Squamous Cell Carcinoma – a Systematic Review with Meta Analysis [Internet]. Vol. 25, Pathology & Oncology Research. 2019. p. 447–53. Available from: http://dx.doi.org/10.1007/s12253-019-00588-2

22. Zafar A, Sherlin HJ, Jayaraj G, Ramani P, Don KR, Santhanam A. Diagnostic utility of touch imprint cytology for intraoperative assessment of surgical margins and sentinel lymph nodes in oral squamous cell carcinoma patients using four different cytological stains. Diagn Cytopathol. 2020 Feb;48(2):101–10.

23. Karunagaran M, Murali P, Palaniappan V, Sivapathasundharam B. Expression and distribution pattern of podoplanin in oral submucous fibrosis with varying degrees of dysplasia – an immunohistochemical study [Internet]. Vol. 42, Journal of Histotechnology. 2019. p. 80–6. Available from: http://dx.doi.org/10.1080/01478885.2019.1594543

24. Sarode SC, Gondivkar S, Gadbail A, Sarode GS, Yuwanati M. Oral submucous fibrosis and heterogeneity in outcome measures: a critical viewpoint. Future Oncol. 2021 Jun;17(17):2123–6.

25. Raj Preeth D, Saravanan S, Shairam M, Selvakumar N, Selestin Raja I, Dhanasekaran A, et al. Bioactive Zinc(II) complex incorporated PCL/gelatin electrospun nanofiber enhanced bone tissue regeneration. Eur J Pharm Sci. 2021 May 1;160:105768.

26. Prithiviraj N, Yang GE, Thangavelu L, Yan J. Anticancer Compounds From Starfish Regenerating Tissues and Their Antioxidant Properties on Human Oral Epidermoid Carcinoma KB Cells. In: PANCREAS. LIPPINCOTT WILLIAMS & WILKINS TWO COMMERCE SQ, 2001 MARKET ST, PHILADELPHIA …; 2020. p. 155–6.

27. Facchin F, Bianconi E, Canaider S, Basoli V, Biava PM, Ventura C. Tissue Regeneration without Stem Cell Transplantation: Self-Healing Potential from Ancestral Chemistry and Physical Energies [Internet]. Vol. 2018, Stem Cells International. 2018. p. 1–8. Available from: http://dx.doi.org/10.1155/2018/7412035

28. Baddour JA, Sousounis K, Tsonis PA. Organ repair and regeneration: an overview. Birth Defects Res C Embryo Today. 2012 Mar;96(1):1–29.