Original Article

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EFFECT OF HYPERBARIC OXYGEN THERAPY ON REGENERATION OF INFRABONY POCKETS DEFECTS TREATED WITH XENOGRAFTS

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ABSTRACT:

Aim of the study: This study aimed to evaluate the effect of hyperbaric oxygen therapy on success rate of regenerative treatment of periodontal infrabony bony defects after treatment with xenografts.

Materials and methods: Sixteen patients suffering from chronic periodontitis with infrabony defects were selected to participate in the present study. The patients were divided into two groups, both group received deproteinated Bovine Bone (Inter Oss)®, only the study group SG received HBO thereby. after the first stage of periodontal treatment, both groups were received deproteinated Bovine Bone (xenografts). the study group were only received (HBO). marginal bone height and density were evaluated at the time of treatment T0, 6 months (T6), 12 months (T12) after treatment using preapical and Bioquant software.

Results: All individuals showed pocket depth reduction, clinical attachment gain and increase in bone density through a period of one-year follow-up. However, the group that received HBO therapy showed more attachment bone gain and more increase in bone density than the control group.

Conclusion: Hyperbaric oxygen therapy is valuable and effective treatment for chronic periodontitis patients treated with open flap surgery and Xenograft as it reduces bone loss and increase bone density in the infrabony defects.

Keywords: Hyperbaric oxygen, Periodontal diseases, Xenografts.

INTRODUCTION:

Periodontal disease is a bacterial associated inflammatory process characterized by the destruction of alveolar bone connective tissue supporting the teeth.[1] The loss in attachment apparatus leads to pocket formation and alteration of normal osseous anatomy.[2] Chronic periodontitis is the most common type of periodontal diseases and result from extension of the inflammatory process to the deeper periodontal tissues. The aim of effective treatment in periodontal diseases is to arrest the inflammatory process by removal of the subgingival plaque biofilm and to establish a local environment and micro flora compatible with periodontal health. The treatment offered to the periodontal patient by the clinician may be nonsurgical or surgical mechanical debridement alone or in combination with bone grafts and guided tissue regeneration.[3-5] The main goal of periodontal treatment is to restore the destroyed tissues and replacing them by new attachment apparatus. Several regenerative modalities have been used for the treatment plan of intra bony defects and regeneration of the periodontium, including closed or open flap surgery combined with other procedures.[6] Non-surgical root debridement of periodontal pockets results in resolving of the

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inflammatory processes, small gain in the periodontal attachment, significant reduction in probing depth and formation of long junctional epithelium.[7] Essam et al 2015 provided that, guided tissue regeneration (GTR) provided acceptable results in prevention of junctional epithelium.[8] Bovine derived bone replacement grafts (xenografts) is among these regenerative modalities, processed for the elimination of its organic part leaving a hydroxyapatite ‘‘skeleton” of a microporous structure of cortical and cancellous bone, resembling that of human body. It has been suggested that this type of graft acts as an osteoconductive scaffold and enables bone growth with subsequent integration with host’s bone.[9] InterOss (Geistlich-Pharma, CH-6110 Wolhusen, Switzerland) is one of the most well-known and commercially available product in this category and has been associated with the successful management of infrabony and interradicular defects.[10,11] The present study is designed to shed some light on the effect of HBO on regenerative treatment of chronic periodontitis patients with infra bony defects.

Hyperbaric oxygen (HBO) therapy is the inhalation of oxygen at high pressure, for therapeutic benefits. According to the Committee on Hyperbaric Medicine; HBO is “A mode of medical treatment in which the patient is entirely enclosed in a pressure chamber and breathes 100% oxygen at a pressure more than one atmosphere absolute (ATA).” ATA is the unit of pressure and 1 ATA is equal to 760 mm of mercury or pressure at sea level. Normal breathing contains 21% O2 at sea level pressure, tissues obtain their oxygen from that combined to hemoglobin (95% saturated). 100 ml blood carries 19 ml O2 combined with hemoglobin and 0.32 ml dissolved in plasma. At the same pressure if 100% O2 (oxygen) is inspired, O2 combined with hemoglobin increases to a maximum of 20 ml and that dissolved in plasma to 2.09 ml. The higher pressure during HBO treatment resulted in more O_2 dissolved in plasma and reach to 4.4 ml/dL at a pressure of 2 ATA and to 6.8 ml/dL at 3 ATA. This additional O2 is responsible for the beneficial effects of this therapy.[12] An increase in tissue oxygen tension generally enhance the healing process.[13] Antibiotic and surgical therapy should be supported by oxygen - rich, which inhibits the anaerobic microorganism’s growth. This mechanism enhancing leukocytes function, activating the body’s local defense mechanisms, which in turn speeds up the healing process. Investigation conducted by **Chen et al. 2012.**[14] provided good evidence that HBO2 inhibits the growth of subgingival obligate anaerobes and facultative anaerobes and Bacteroides melaninogenicus thus promoting healing of Periodontium. High oxygen tension, resulted in increasing regenerative processes.[15] **Chen et al. 2002** showed that HBO increases local oxygen distribution, especially at the base of the

periodontal pocket. This could inhibit the growth of anaerobe bacteria.[16]

MATERIALS AND METHODS:

Patients' selection

Sixteen individuals (8 men/8 women, mean age of 46.9 years) All patients diagnosed as having a chronic periodontitis with infrabony defects, a complete examination was given to all patients participate in the study and the materials that would be used, and they give their agreement.

Treatment groups

The 16 patients (n=16) were divided into two groups (n=8). The two groups treated surgically using open flap surgery, bone defects filled with InterOss bone graft:

1. Study Group (SG) received InterOss bone graft and exposed to HBO therapy.
2. Control Group (CG) received the InterOss xenograft alone.

Patients were included in the study, provided that they fulfilled the following criteria:

1. Free from systemic disease according to the criteria of Cornell medical index.[16]
2. Female patients should not be pregnant or on contraceptive pills.
3. Non-smoker and co-operative.
4. No history of periodontal surgery in the diseased region.
5. The probing depth of the selected cases should be > 6 mm.

Exclusion criteria include: third molars, endodontic treated teeth, teeth with overhanging restorations, teeth with grade 3 mobility and in general all teeth with a hopeless prognosis at the combined clinical and radiographic evaluation. The study was conducted according to Rules of Helsinki Declaration. Patients were informed about the study protocol and objectives before they signed an informed consent. The periodontal conditions were evaluated for each patient at different intervals pre-and post-operative for all subjects using the following clinical parameters:

Plaque Index (PI),[17] Gingival Index (GI),[18] Clinical attachment level (CAL),[19] and Probing pocket depth (PPD).[20]

Initial mouth preparation:

All individuals received through scaling, root planning and polishing, oral hygiene instructions with plaque control regimen; brushing for 2 – 3 minutes three times daily, flossing and or wooden tips morning and night. Re-evaluation phase was carried out at two months after the initial phase therapy.

Surgical procedures:

Following phase I periodontal therapy, the area which were to undergo the procedure was adequately anesthetized with 2% lignocaine and 1: 80,000 adrenalines, full-thickness mucoperiosteal flaps were performed, all granulated tissues were removed with through curettage and root planning.

InterOss grafts granules were mixed with saline, then inserted in the infrabony defects for all the individuals (Fig 1). Flaps were held in place by means of non-resorbable silk 3-0 sutures and covered by periodontal pack.

Patients were given all the postoperative instructions and were prescribed analgesics. Adequate plaque control measures involving rinsing with 0.12% Chlorhexidine gluconate twice daily for about two weeks was advocated. Sutures were removed after 2 weeks.

Hyperbaric Oxygen Therapy (HBO)

On the second day after surgery, patients of SG were placed on a protocol of twenty sessions of HBO therapy (per month) in the multi place Hyperbaric therapy were completed under the supervision of hyperbaric medical specialist at Egyptian Air Force Aero-Medical Institute, Cairo, Egypt , while, patients of CG received no therapy.[22,23] The period of each session was 90 minutes under pressure of 2.4 ATA.[22,24]

Each session consisted of three phases: compression pressurization (where the room pressure was raised from 1 ATA to 2.4 ATA for 15 minutes), oxygen breathing (for one hour at 2.4 ATA) and decompression pressurization for 15 minutes from 2.4 ATA to 1 ATA24 (Fig. 2).

Recall maintenance visits:

- Recall visits at 1, 2 and 4 weeks after surgery, then at 3, 6, 9 and 12 months.
- Professional oral hygiene reinforcement. No periodontal probing and/or subgingival re-instrumentation of the surgically treated sites were performed prior to 3 months of healing.

Radiographic Evaluation:

All patients were exposed to standardized periapical radiographs were taken before and immediately after surgery and at intervals of 3, 6, 9, and 12 months post-operatively. (Fig 3)

Imaging Analysis:

(Bioquant). It is image analysis software that is used for different analysis applications (histo-morphometric as well as densitometric analysis). In this software the area to be measured which called Regions of Interest (ROI) was selected (color density selection). A single pixel that represents a specific color (white pixels in radiographs) is selected or threshold allowing for automatic selection of all other pixels in the ROI that threshold areas are traced and counted as a number of pixels that can be calculated as a ratio of the whole ROI. Bioquant was used for calculation of the average density of the crystal bone. Average density is determined based on a scale of 0-256 and the number 256 (8 bits) stands for the whitest pixel on the screen while number 0 represents the areas of the darkest pixels on the screen.

Statistical analysis

The statistical analysis of data was performed using Excel program and SPSS program (Statistical Package for Social Science) version 22.0. One-Sample Kolmogorov-Smirnov Test was used to diagnose normality of data distribution of all variables. The data was parametric and normally distributed and were presented using mean ± standard deviation. Between-groups comparisons for attachment gain and bone density were performed using student t-test. Repeated measure ANOVA followed by LSD was used to detect significant differences between observation times. P-values <0.05 were considered to be significant.

RESULTS:

From table 1,2 and 3 which shows mean and ±SD values of PD, CAL and bone density for both groups at T0, T6, T9 and T12. During the period of the study no abnormal reaction, no complication was observed post-operatively. The results of the examined groups of the present study were recorded.

Changes in Plaque Index (PI) and Gingival Index (GI):

Results of this study of both groups showed no significant difference between the two groups regarding PI and GI. There is significant difference among each group at all intervals of the study compared to the baseline. These results because of patient's cooperation and good professional oral hygiene measures.

Changes in Pocket Depth (PD):

There is significant difference among each group at 6, 9.12 months when compared to the baseline (table 1& Fig 4). When SG compared with CG at 9, 12 months of the surgery showed significant difference

Changes in Clinical Attachment Level (CAL): There is significant difference in each group when compared with the base line at 6, 9, 12 months (table 1& Fig 4). When SG compared with CG at 9, 12 months of the surgery showed significant difference.

Changes in Bone Density:

There is significant difference in each group when compared with the base line. When SG compared with CG at 9, 12 months of the surgery; showed significant difference (table 3& Fig 6).

DISCUSSION:

Although HBO was used in various researches conducted by several investigators yet, the frequency, and cumulative number of sessions for HBO have not been standardized.[23] **Chen et al. 2002**showed that HBO increases local oxygen distribution, especially at the base of the periodontal pocket. This could inhibit the growth of anaerobe bacteria.[16] HBO produces a temporarily more limited effect on the periodontal anaerobe load, which later returns to the pretreatment values. The present study resulted in significant reduction in probing depth (PD), clinical attachment

loss (CAL) and increase in bone density , were seen in both groups at T6, T 9 T 12 when compared with base line and these results attributed to regenerative effect of the implanted bone grafts, however; there were significant differences in the HBO + bone graft in the study group SG compared to the control group CG which in agreement with study by **Chen et al. in 2003**, who reported the beneficial effects of HBO in a controlled study of periodontitis. It was concluded that HBO had good therapeutic effect on severe periodontitis, and this effect lasted for >1-year.[25] As regard to plaque and gingival Index scores the present work showed a significant reduction prior surgery, this reduction remained continuous during observation period of these clinical trials, this attributed to effective phase I therapy and patient cooperation. A similar finding agrees with the present work by **Patrick et al 2004.**[26] In addition, **Signoretto et al 2007.**[27] reported that, there is a beneficial effect of HBO therapy on the periodontal therapy which in agreement with the present work. The present study showed significant reduction of pocket depth and gain in attachment level as well as improvement in bone density with HBO technique. These findings are in accordance to **Gupta et al 2005.**[28] The same results of the present study agree with findings obtained by Thom **et al.1987,**[29] they demonstrated that; High oxygen tension, resulted in increasing regenerative process. In the beginning of the study and at three months of the study there is no significant differences between the two groups, that is may be attributed to the low period of time allowed for the HBO therapy to give its effect. HBO also affect management of many restorative materials, according to **Hossam et al in 2007,2009** HBO resulted in improving the bond strength and sealing of composite filling materials.[30,31] In addition, **Naser and Essam in 2018** concluded that, hyperbaric oxygen therapy is valuable and effective treatment as it associated with increased bone density.[32] The present study chose 12 months period for evaluation, this is in accordance to **Rabalaise et al 1981.**[33] they concluded that ;6 months period is short and not enough to fully evaluation of periodontal therapy with grafting technique and contrary to **Becker et al 1986.**[34]

CONCLUSION:

Hyperbaric oxygen therapy is valuable and effective treatment for chronic periodontitis patients treated with open flap surgery and Xenograft as it reduces bone loss and increase bone density in the infrabony defects.

REFERENCES:

1. Cochran D, 2008; Inflammation and bone loss in periodontal disease. J. Periodontol. 79, 1569–1576
2. Garett S; Periodontal regeneration around natural teeth. In: proceedings of the 1996 world workshop in

periodontology. Ann. Peridontol; 1996, 7: 621.

3. Hujoel P: Endpoints in periodontal trials: the need for an evidence-based research approach. Periodontol 2000, 2004; 36, 196–2004.
4. Becker W, Becker B, Berg L & Samsam C: Clinical and volumetric analysis of three-wall intrabony defects following open flap debridement. J. Periodontol, 1986b.57: 277.
5. Gantes B, Garrett S & Egelberg J: Treatment of periodontal furcation defects (II). Bone regeneration in mandibular class II defects. J. Clin. Periodontol, 1988; 15: 232 – 239.
6. Cortellini P, Pini Prato G & Tonetti M: Periodontal regeneration of human intrabony defects. I. Clinical measures. J. of Periodontol 1993a; 64, 254–260.
7. Herrera D, Sanz M, Jepsen S, Needleman I & Roldan S: A systematic review on the effect of systemic antimicrobials as an adjunct to scaling and root planning in periodontitis patients. J. Clin Periodontol. 29(Supply 3)2002: 139-159.
8. Essam et al; Clinical and radiographic evaluation of periodontal intrabony defects by open flap surgery alone or in combination with Biocollagen membrane. 2015, Volume 5, Issue : 3 : 190—198.
9. David S.H. Lee, Y. Pai, Steve Chang; Physicochemical characterization of InterOss_ and Bio-Oss_ anorganic bovine bone grafting material for oral surgeryMaterials Chemistry and Physics 146 (2014) 99-104.
10. Richardson C, Mellonig C, Brunsvold J, McDonnell M, Cochran H, . 1999. Clinical evaluation of Bio-Oss: a bovinederived xenograft for the treatment of periodontalosseous defects in humans. J. Clin. Periodontol. 26, 421–428.
11. Taheri M, Molla, R., Radvar, M, Sohrabi, K., Najafi, M, 2009. An evaluation of bovine derived xenograft with and without a bioabsorbable collagen membrane in the treatment of mandibular class II furcation defects. Aust. Dent. J. 54, 220–227.
12. Gupta V, Vijay S, Gupta R& Koul S: Hyperbaric oxygen therapy. JK Pract 2005;12: 44-7.
13. Signoretto C, Bianchi F, Burlacchini G, Canepari P. Microbiological evaluation of the effects of hyperbaric oxygen on periodontal disease. New Microbiol 2007; 30:431-7.
14. Chen T, Xu B, Liu J, Li S, Li D, Gong G et al: Effects of hyperbaric oxygen on aggressive periodontitis and subgingival anaerobes in Chinese patients. J Indian Soc Periodontol 2012; 16:492-7.
15. Thom S; Hyperbaric oxygen therapy in septicemia. J Hyperb Med 1987;2 :78-98.
16. Chen T, Zhou Y, Liu J, Xu B, Wu Z, Li D. Biological effects of HBO on human severe periodontitis. Underseas Hyperb Med Soc 2002; 29:159-66.

17. Oleary J, Drak R & Naylor J: The plaque control record. J. Periodontol. 1972; 38:43.
18. Loe H: The gingival index, plaque index and the retention index systems J. periodontol. 1967; 38:610 (supplement).
19. Abramson J: The cornell medical index as an epidemiological tool. AMJ, puplic health1966, 56:287-298.
20. Ramfjord S: The periodontal index, J. periodontol.1967; 38; 604-610.
21. Polson M, Yeaple R& Zande H: Histologic determination of probe tip penetration into gingival sulcus of human using an electronic pressure, sensitive probe; J. Clin. periodontol; 7; 479-488.
22. Rizk F, Shaheen N. Hyperbaric Oxygen Therapy for Promoting Osseointegration Around Dental Implants in Heavy Smokers. Egyptian dental Journal. 2011;57(3):2371-2380.
23. Eid H, W. ES: The effect of hyperbaric oxygen therapy on improving bony stability in LeFort I maxillary advancement. UHM 2011; 38:215-224.
24. Gottrup F: Oxygen in wound healing and infection. World journal of surgery. 2004;28(3):312-315
25. Chen T, Lin S, Liu G, Liu J, Song P, Xu B et al: Effects and holding time of hyperbaric oxygen on human severe periodontitis. Shanghai Kou Qiang Yi Xue 2003; 12:403-5.
26. Patrick A& Luaruence M: Effect of nonsurgical periodontal therapy on hard and soft tissues.J. Periodontol 2000. 2004, 138 – 212.
27. Signoretto C, Bianchi F, Burlacchini G, Canepari P; Microbiological evaluation of the effects of hyperbaric oxygen on periodontal disease. New Microbiol 2007;30: 431-7.
28. Gupta V, Vijay S, Gupta R, Koul S; Hyperbaric oxygen therapy. JK Pract 2005; 12:44-7.
29. Thom S; Hyperbaric oxygen therapy in septicemia. J Hyperb Med 1987; 2:78-98.
30. Hossam M, Sameh M; effect of HBO on the sealing ability of different restorative materials 2007; Ain Shams den. J vol x; 127-137.
31. Hossam M, Ola A; effect of HBO on the tensile bond strength of repaired composite resin under different dentin bonding agents 2009; Egyptian den. J vol 55; 2685: 2690.
32. Nasser H. Shaheen, Essam I. Elkhatat; Hyperbaric oxygen therapy effect on osseointegration of dental implants retain mandibular overdentures with bisphosphonate treated osteoporotic patients. Egyptian den. J. 2018;64(2):2371-2380.
33. Rabalais M, Yukna R& Mayer E: Evaluation of Durapatite ceramic as an alloplastic implant in periodontal osseous defects. J. Periodontol. 1981; 52: 680.
34. Becker W, Becker B, Berg L & Samsam C: Clinical and volumetric analysis of three-wall intrabony defects following open flap

debridement. J. Periodontol, 1986b.57: 277.

TABLES & FIGURES:

Fig (1). Figure showing bone graft in place.

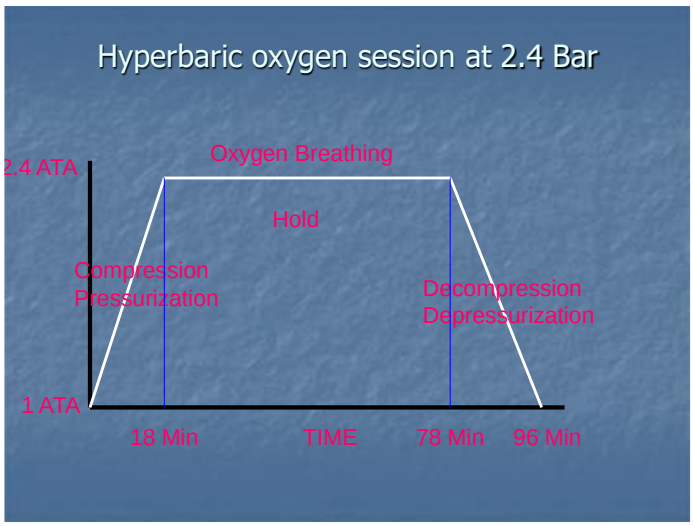

Fig. (2) Figure showing hyperbaric oxygen session at 2.4 ATA.

Before ***after***

Fig (3). Figure showing preapical radiograph of infrabony pockets pre-& post HBO treatment.

Table 1:Comparison between deference ±SD values of PD for both groups at different intervals

	Group A X±SD	Group B X±SD	Independent samples t-test (p value)
Base line (T0)	6.65±0.21	6.61±0.24	0.32
3 months (T3)	5.32±0.23	5.91±0.43	0.01
T 6	4.94±0.22	5.11±0.33	0.45
T 9	4.11±0.21	4.91±0.21	0.003*
T 12	3.37±0.22	4.55±0.28	0.001*
Paired sample t-test (p value)	0.03*	0.05*	

X; mean. SD; standard deviation. * Significant difference at 0.05

Figure 4: Histogram of the deference values of PD for both groups at different intervals

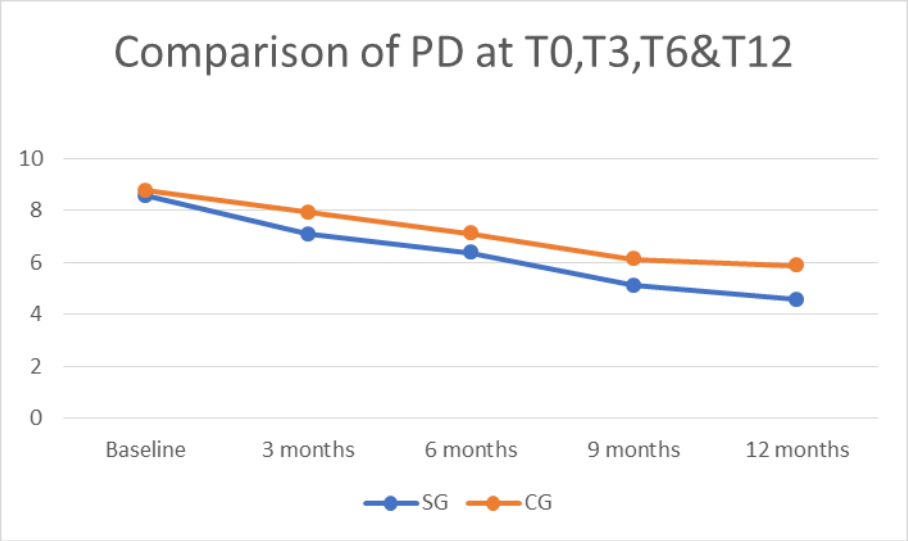

Table 2: Comparison between the deference of CAL for both groups at different intervals

	Group A X±SD	Group B X±SD	Independent samples t-test (p value)
Base line (T0)	8.57±0.21	8.77±0.24	0.32
3 months (T3)	7.07±0.23	7.91±0.43	0.01
T 6	6.37±0.22	7.11±0.33	0.45
T 9	5.11±0.21	6.41±0.21	0.003*
T 12	4.57±0.22	5.87±0.28	0.001*
Paired sample t-test (p value)	0.03*	0.05*	

X; mean. SD; standard deviation. * Significant difference at 0.05

Figure 5: Histogram of the deference values of CAL for both groups at different interval

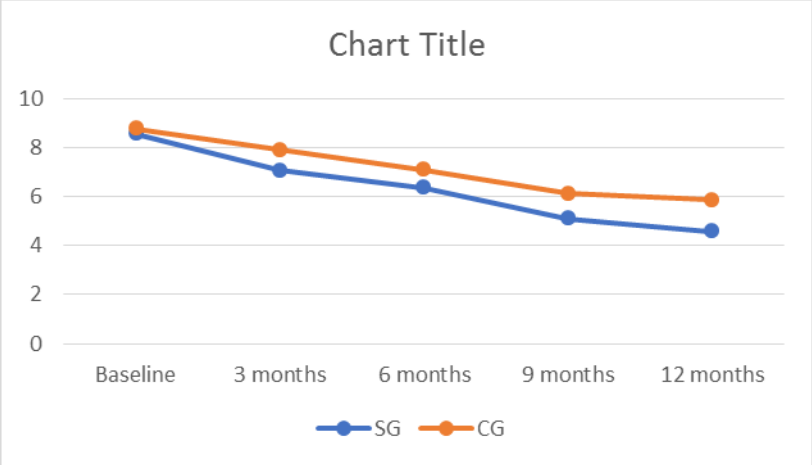

Table 3: Comparison between the deference of bone Density for both groups at different intervals

	Group A X±SD	Group B X±SD	Independent samples t-test (p value)
Base line (T0)	8.57±0.21	8.77±0.24	0.32
3 months (T3)	7.07±0.23	7.91±0.43	0.01
T 6	6.37±0.22	7.11±0.33	0.45
T 9	5.11±0.21	6.41±0.21	0.003*
T 12	4.57±0.22	5.87±0.28	0.001*
Paired sample t-test (p value)	0.03*	0.05*	

X; mean. SD; standard deviation. * Significant difference at 0.05

Figure 6: Histogram of deference values of Bone Density for both groups at different interval