Case study

Clinical and radiographic findings without the use of bone substitute materials in extraction sockets and delayed implant placement- A case series

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ABSTRACT

Aim: To observe clinically and radiographically (CBCT), the extent of bone resorption in extraction socket without the use of bone graft substitutes and delayed implant placement.

Material and methods: 50 compliant patients were selected for study. All the patients who were advised extraction were followed up for entire duration of the treatment, at 5th week CBCT showed horizontal and vertical bone loss. To prevent further bone resorption, after 5 weeks implant was placed along with bone graft.

Results: Bone resorption after extraction is an unavoidable phenomenon. Clinical and radiographic (CBCT) analysis showed massive bone resorption by 5th week. At 5 month CBCT, all patients showed stable implant integration. There was no implant failure at the end of the study.

Conclusion: Alveolar preservation is proven to slow down socket wall collapse with the use of a bone substitute material without which larger procedures maybe needed to restore alveolar integrity and harmony. Immediate implant placement is effective when bone graft is placed in the jumping distance.

1. Introduction

Bone is a complex tissue and its better understanding can bestow better health on patients by the clinicians. The skeletal system serves two main functions, one of protecting the vital internal organs and secondly a metabolic function by acting as a reserve of calcium and phosphate required for maintaining serum ions and for the proper presentation of growth, and bone of the maxillary arches is no different in fulfilling these two purposes. The latter happens by the process of remodeling which also helps in maintaining the shape, size and quality of the bone.¹ The process of remodeling is a continuous process which was first explained by Frost in 1976 and takes place by different cells working as a team, which are collectively known as basic multicellular unit (BMU).² This one complete cycle of bone resorption and deposition is known as bone sigma. So if one has to define a bone sigma it can be easily stated as 'the number of days it takes BMUs to quantify complete remodeling in a fixed two dimensional slice through a region of bone', which takes about 120 days in humans.

Bone remodeling follows a pattern of activation, resorption and then formation, also known as the ARF sequence.² The term remodeling should not be confused with modeling, in the former there is measurable replacement of resorbed bone, and in latter only one thing will take place, either resorption or formation, but not both.² Thus, in the alveolar bone, as soon as extraction of the tooth takes place, there is remodeling, even if bone graft is placed for socket preservation or not placed, there will always be remodeling of the socket, which is a continuous process. Unfortunately, this remodeling after tooth extraction results in major resorption of the bone, shrinking the size of the socket to less than half of its original size. This can be attributed to the disuse atrophy, which was first explained by Roux in 1881, which was later supported by Wolf's law given in 1892. However, our understanding about bone tissue and its behavior has come a long way from the literatures of 19th century. So what happens during socket healing without and with immediate implants? Are bone graft substitutes paramount in socket healing? How will it affect clinical outcome in aesthetic zone? What can be done to prevent socket remodeling or

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Fig. 1. Pre-operative IOPA

Fig. 3. Extraction.

rather can it be controlled? These are some of the questions which clinicians are battling from past many years, some we just have to accept and on some we have to work upon to get the desired results. This simple study was conducted to answer some of such questions.

2. Material and method

To answer the aforementioned questions, 50 patients who had to undergo extraction or visited dental office for a check-up and were planned for tooth extraction and implant placement were kept on a follow up (Figs. 1 and 2). After complete investigations patients who did not have any medical condition or had controlled diabetes and heart conditions underwent extraction of the concerned tooth. Under aseptic conditions, standard protocols were followed towards atraumatic extraction, which was done to protect the socket wall from collapsing (Fig. 3). However as observed on 2nd day after extraction, 2 weeks, 3 weeks (Fig. 4) and 5 weeks interval (Fig. 5), evident collapse of the soft and hard tissue is visible and at 5th week, as can be seen in the image (Fig. 6), CBCT and 3 dimensional reconstruction showed loss of horizontal and vertical bone upto middle one-third. After 5 weeks an implant was placed to stop further ridge collapse (Fig. 7). Bone graft substitute (NobaBone Morsels) was placed along with a ePTFE

Fig. 4. 3 weeks.

Fig. 2. Pre-operative CBCT

membrane (Bio Mem, Korea) (Fig. 8) and water tight closure was given with cytoplast sutures. Postoperatively, patient was comfortable without any complications. Standard protocols were followed towards post-surgery medication and patient instructions. At 5 months CBCT shows stable implant without any signs of failure. There is good bone all around the implant (Fig. 9). A 2 year follow up was maintained with the patient (Fig. 10).

3. Results

All the 50 cases that were followed up showed variable bone loss at 5 weeks. Soft tissue healing in some patients took 1 week more or 1 week less depending upon the oral hygiene they maintained. At 5 weeks there was no clinical evidence of collapse of vertical bone height, but CBCT showed loss of bone structure vertically and horizontally. Post operatively, healing was uneventful in all the cases, except 7 cases, where there was transient swelling that lasted for 7–10 days. Those patients were given medication for the same. There was no loss of implant at 2 year follow up in any of the cases. Patients were called for regular check-ups and scaling and root planning was done whenever required.

Fig. 5. 5 weeks.

4. Discussion

As aforementioned, remodeling is the physiological process that occurs in the body in all the bone types between osteoclasts and osteoblasts, wherein the former cells lay a foundation for osteoblasts to form bone by forming an acidic microenvironment resorbing organic and inorganic substances.³ This happens because of the coupling mechanism that exists between the two cells by which approximately 2%–5% of cortical bone is remodeled each year, but remodeling in trabecular bone can be up to 10 times higher due to larger surface to volume ratio.⁴ Recent literature shows that osteocytes act as mechanosensors and communicate with each other to initiate the process of remodeling.⁵ This concept of cell-to-cell communication is based on the original idea of Roux⁶ which stated that bone remodeling is a self-organizing process, which was then included by Frost in his mechanostat theory,⁷ according to which local strain regulates bone mass and new bone is formed when strain levels exceed ‘set-point’ and if the strain

Fig. 7. Implant placement: Clinical and radiographic images.

Fig. 8. Placement of bone graft and ePTFE membrane.

Fig. 6. 5 weeks CBCT along with 3D reconstruction of the lost tissues.

Fig. 9. 5 month CBCT

Fig. 10. 2 year follow up.

levels are below this set-point bone resorption will take place. However, the mechanostat theory does not define remodeling at the molecular or cellular level. Hence, when a tooth is extracted, due to absence of external mechanical stimulator such as intraoral forces and biting forces, there is rapid resorption of the bone and modeling takes places instead of remodeling. In modeling, the activity of cells is similar to that which occurs in remodeling, but resorption and deposition of bone is not balanced, causing changes in the micro-architecture.⁸ This communication amongst cells or the coupling mechanism is aided by the growth factors, Semaphorins, cytokines, hormones, calcitonin, 1,25-dihydroxyvitaminD3, glucocorticoids, androgens, and estrogens.^{9–11}

It can be seen that the cycle of bone formation and resorption is a complex process¹² where many of the involvements between the cells and role of molecules has not been fully understood. But, what has been understood on a clinical level is that as soon as a tooth extraction is done, alveolar ridge undergoes modelling and remodeling resulting in bone resorption unsuitable for implant placement, which can be supported by vast literature, stating rapid resorption of alveolar bone after tooth extraction,^{13,14} maximum of which occurs in the first 6 months.¹⁵ According to Schropp et al. two thirds of the hard and soft tissue changes occur in the first 3 months and 50% of crestal width to be lost in a 12-month period, 2/3 of which occurred in just the first 12 weeks.¹⁶ Studies have shown that bone resorption occurs in two stages, in the first stage bundle bone is replaced with woven bone leading to

loss of bone height especially in the buccal region.¹⁷ Cardaropoli et al.¹⁸ through experiments stated that at 4 weeks, during the natural process of socket healing, the blood clot is being replaced with woven bone, a fast forming bone with no load bearing capacity. In another study by Araújo and Lindhe,¹⁹ in an experimental study in dogs, observed resorption in buccal and lingual walls due to marked bone ‘modelling’ activity (osteoclastic activity). This explains the phenomenon taking place in the 50 cases discussed in the current study, which can be seen on the CBCT as well.

To stop this collapse of bone, most common concepts like socket preservation, immediate implant placement along with grafting in jumping distance¹⁹ came into existence. Socket preservation is a well understood concept which is frequently done to maintain socket's dimensions and prevent bone collapsing especially in the aesthetic zone. Immediate implant placement has various advantages however factors such as its position, quality of the bone, buccal bone width, jumping distance, need for regenerative procedures and surgical technique should be kept into consideration²⁰, but as we have understood so far that bone is in continuous state of flux so does placing immediate implant stops socket from collapsing?

In 2005, Araújo and Lindhe.²¹ presented the results of first experiment from a series of three and concluded that after 3 months of immediate implant placement, the socket collapse was equal to sockets without immediate implant placement. Thus, the placement of an implant in the fresh extraction site had failed to prevent/control bone modelling. In the results of following two studies, two important questions were addressed: the role of (i) early osseointegration, and (ii) socket dimension.^{22,23} And the authors concluded that at 12 weeks the healing process was ongoing, however, osseointegration established during early phase of healing was in part lost due to continuous resorption of buccal bone. Thus the studies state that immediate implant placement fails to stop or control the process of modelling. They also stated that thinner walls and implant closer to buccal wall results in compromised healing and bone dehiscence. Which may result in unfavourable aesthetic outcomes. For the very same reason, authors suggest placement of bone graft along with implant placement or socket preservation and delayed placement of implant. And so the concept of jumping distance came into existence.¹⁹ And the same technique authors had followed in the current study, where bone graft was placed along with implant placement. If further delay in implant placement would have been done, collapse of the ridge would have been more, making the patient to undergo advanced and lengthier surgical procedures, making the alveolar bone dimensionally unsuitable for implant placement.

5. Conclusion

Alveolar preservation is proven to slow down socket wall collapse with the use of a bone substitute material without which larger procedures maybe needed to restore alveolar integrity and harmony. Immediate implant placement is effective when bone graft is placed in the jumping distance.

Author contribution

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Lanka Mahesh: Conceptualization, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Writing - original draft, Writing - review & editing. **Jose Luis Calvo Guirado:** Conceptualization, Funding acquisition, Investigation, Project administration, Supervision, Validation, Writing - review & editing. **Sagrika Shukla:** Conceptualization, Data curation, Methodology, Validation, Writing - original draft, Writing - review & editing. **Varun Raj Kumar:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Visualization. **Yuvika Raj Kumar:** Data curation, Funding acquisition, Resources, Software, Visualization.

Declaration of competing interest

None.

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