Review article:

FEM analysis of single implant retained mandibular overdenture with four different attachment types: A review

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Abstract:

Background: Dentistry science has evolved over the years. According to a 2012 report, submitted by epidemiology department, it was found that 62% people completely lose their teeth out of which 19.2% in mandibular area and 12.2% in maxilla. So the study is done with a specific focus on design of new attachment, in order to increase retention and stability of single implant retained overdentures used to conquer edentulism.

Materials and Methods: An electronic search with the keywords like overdentures, implant, single implant overdentures, single implant vs two implant, biomechanical behaviour was carried out on Science Direct, Researchgate and Google Scholar. Open access articles were obtained whenever possible and other inaccessible articles were requested from corresponding authors. The referred articles in previous studies were also obtained or requested.

Results: The search resulted in total of 52 articles out of which 19 articles were within the specified criteria. Among the 19, 3 articles were on conventional dentures vs single implant overdentures, 4 compared the single implant overdentures and two implant overdentures, 2 are related to implant location, 3 articles discussed types of attachments, prosthetic maintenance of implants was studied in 3 articles, 2 articles were on immediate loading / early loading and 2 on biomechanical behaviour of single implants.

Conclusions: The study concludes that single implant supported overdentures can be a cost effective solution for middle class people with same retention and stability like multiple implant supported overdentures.

Keywords: Overdentures, Implant, Single Implant Overdentures, Single Implant vs Two Implant, Biomechanical Behaviour

Introduction

Dentistry science has evolved over the years since its introduction in nineteenth century. It has provided numerous solutions for edentulous people, ranging from Branemark implants to recently developed root analogues implants. Edentulism is the phase in which natural teeth are completely lost[¹]. Statics revealed that out of 62% edentulous people 19.2% is suffering from mandibular failure and 12.2% from maxillary failure[²]. For such a people dentures are the source to rely on. But again with conventional dentures, there is an issue of retention and stability². To overcome this problem overdentures supported by implants were applied successfully. Implant supported overdentures gave comfort, stability &painless option for edentulous patients. It enhanced
the quality of life and oral health. But the major problem with overdentures was its high cost. Also clinician always received complaints regarding retention of the overdentures, particularly about overdentures fixed in mandibular bone. Number of clinical trials has shown that single implant supported overdenture offers good retention and it is also a viable alternative when cost is considered. The studies also shown that within single implants supported overdentures, implants with ball attachment provide a much satisfactory retentions and stability. But the evaluation of effectiveness of new attachment types other than conventional attachment type is still being untouched. So the study is focused on designing of an attachment, which in will increase retention and stability of single implant retained overdentures fixed in mandibular portion.

Material and methods
A systematic review on single implant retained mandibular overdenture is conducted using combined mandibular prosthesis studies, dental implant studies and clinical randomized trials. The aim is to identify publications related to single implant retained mandibular overdenture up to 2015. An electronic search with the keywords like overdentures, implant, single implant overdentures, single implant vs two implant, biomechanical behaviour was carried out on Science Direct, Researchgate and Google Scholar. Open access articles were obtained whenever possible and other inaccessible articles were requested from corresponding authors. The referred articles in previous studies were also obtained or requested.

Results
The search ended in a total of 52 articles. Out of 52, 19 articles were selected with due consideration to year of publication, type of study and relevance with the study undertaken. Out of 19, 3 are on conventional dentures vs single implant overdenture, 4 are on single implant overdentures vs two implant overdentures, 2 are on implant location, 3 are on types of attachments, 3 are on prosthetic maintenance of single implants, 2 are on immediate loading / Early loading, 2 are on biomechanical behaviour of single implants and so on. These studies are investigated carefully in the context of the current study and important conclusions are drawn.

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Conventional denture Vs single implant overdentures:
Cordioli G et al\(^3\) in 1997, first conducted a five year study for evaluation of overdenture anchoring by single implants. He treated 21 patients by inserting implants into mandibular midline in two stages. Success rate of implant, oral comfort, soft tissue condition were evaluated over the period. One this basis they concluded that overdenture success rate with single implant support is comparable with that of two, three four implants support. Krennmair G et al\(^4\) in 2001 submitted clinical study of nine patients
with an average age of 82.2 years. The patients were treated with single symphyseal implant overdenture provided with ball attachment at anchorage. Result showed that due to single implant edentulous patient felt comfort and satisfaction.

Wolfart S et al\(^5\) in 2008 conducted two clinical trials in which single implant was inserted in the centre of the mandible with ball attachment and with screw presented matrix. Result showed improvement in chewing ability, retention, stability and quality of life of edentulous people.

**Single implant overdenture vs two implant overdenture**

Walton JN et al\(^6\) evaluated randomized clinical trial of 86 patients. One midline or two bilateral implants in mandible conventional overdentures was provided. The commencement lead to the conclusion that satisfaction of patient in case of single implant is same as two implant and lower cost.

Liu J et al\(^7\) studied the biomechanical nature of implants & their influence. He concluded that no strain concentration damaging occurred in surrounding of single implant retained mandibular overdenture. Grageda E et al\(^8\) in 2014 submitted a report concluding single implant retained overdenture is cost effective than two implant supported overdenture.

Bryant SR et al\(^9\) recently compared the use of single implant and two implant supported overdentures by taking randomized clinical trials for five years. Same satisfaction levels were observed with both type of overdentures and retention was also comparable.

**Types of attachments**

Nabeel Alsabeeha et al\(^{10}\) in 2010 conducted effect of six different attachment systems from which two are prototype ball attachment having wide dimensions another three are commercially used ball and stud attachment with standard measurements. Five samples are taken from each attachment which is further connected to three different implants. Result showed the highest retention can be achieved with prototype ball attachment because of its larger dimensions.

Sethi T et al\(^{11}\) studied a 62 year edentulous female, who was unsatisfied with retention and stability of denture, for 5 years. The patient was offered several treatment options and based upon CT scan & financial support available with patient, single implant overdenture with magnetic attachment was selected for treatment. It was observed that single implants with magnetic attachment can be a good treatment option.

Kono K et al\(^{12}\) in 2014 evaluated stress breaking ball attachment and compared it with conventional ball attachment. They found that less pressure at each area of stress breaker ball attachment than conventional ball attachment.

**Implant location**

Len Tolstunov\(^{13}\) in a comparative study compared the various functional implant zones (FIZ) and their cumulative success rates. The conclusion was, implant location is also a vital factor, affecting the success and failure of implants. Within study they also found that the average cumulative success rate is highest for anterior region (97%) of mandible bone and lowest for posterior region (77%) of maxilla bone.

Judith A. Porter et al\(^{14}\) in 2005 reviewed clinical study which shows the success rate of implants in maxilla as 70% and 75% in mandible. He also gave predictors for implant success like bone quality and quantity, implant placement, patient habits (smoking, chewing gutkha), infections, improper prosthetic design etc.
Immediate loading vs early loading
Glenn Liddelow et al. treated about 35 patients having poor retention, instability and phonetic problems regarding mandibular overdentures. A single implant with ball attachment was inserted at mandibular midline and was studied over a period of 36 months. The research design resulted in high patient satisfaction with less complications and increased comfort at least possible cost.
Alsabeeha N et al. carried a study over 3 groups, each containing 12 edentulous patients, with 3 different implant-attachment combinations. The 3 combinations were, southern regular implant and ball attachment, southern 8 mm wide implant and large ball attachment, Neoss regular implant and locator attachment. Result showed wide diameter implants require lower maintenance and immediate loading of single implant overdenture found to be successful and optimum cost option for avoiding Edentulism.
Nicole Passia et al. are evaluating 180 edentulous patients with randomized controlled clinical trials. If implant insertion is done either immediately after tooth extraction or after a 3 months delay then retention ability develops more. Also less pain, more satisfaction, low surgical protocol, and maintenance was offered.

Prosthetic maintenance
Nicole Passia et al. performed a pilot study with an aim of proving the efficiency of single midline implant supported overdenture and its maintenance. The study commenced with insertion of single implant, in the middle of mandible, in 11 edentulous patients. The dentures then relined and ball attachment was provide after couple of months. In this very study patients were instructed that before intervention they should maintain oral hygiene especially when denture bases reinforced with metal framework.


Discussion
The proper review of clinical trials, studies, dental implants, combined mandibular prosthesis, comparative studies observed that single implant supported mandibular overdenture is cost effective option and can be promising one for the financially weaker edentulous patients. In edentulous mandible, the single implant overdenture gives excellence, better survival rate and improve quality of oral health
life. The single implant survival rate is more in mandible than maxilla. The single implant retained mandibular overdenture is stable and successful long term solution with stability, comfort and less painful surgical intervention.

**Conclusion**

From the above overall literature review it is found that

1) Single implant inserted in the anterior region of the mandibular bone can work successfully at least for a period of time.

2) Compared to two implant supported overdenture, single implant overdentures are cost effective because of use of minimum number of implants and less surgical interventions.

3) Larger dimension attachment provides more retention and stress breaker ball attachment gives less stress distribution.

4) The difference between survival rate of single and two implant inserted overdentures is negligible.

5) Immediate loading of implant is considerably trustworthy and safer compared to multiple implant overdentures.

So it can be concluded that single implant supported overdentures can be a cost effective solution for middle class people with same retention and stability like the multiple implants supported mandibular overdentures.

**References**


9] Bryant SR, Walton JN, MacEntee MI. A 5-year randomized trial to compare 1 or 2 implants for implant over dentures. Journal of Dental Research, 2015, 94(1), 36-43.


