

A comparison of cost and cost-effectiveness analysis of two- implant-retained overdentures versus other removable prosthodontic treatment options for edentulous mandible: A systematic review

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Abstract

Aim: The aim of this study was to examine systematically the data published on the cost and cost-effectiveness of mandibular two-implant-retained overdentures compared to other removable prosthodontic treatment options for edentulous mandible.

Settings and Design: It is a systematic review which analyses the available data from the prospective and retrospective studies and randomized clinical trials to find out costs and cost effectiveness of different removable treatment modalities for completely edentulous mandible . The study protocol was decided according to PRISMA guidelines.

Materials and Methods: The search was limited to English literature only and included an electronic search through PubMed Central, Cochrane Central Register of Controlled Trials, and complemented by hand-searching. All clinical trials published up to August 2019 were included (without any starting limit). Two independent investigators extracted the data and assessed the studies.

Statistical Analysis Used: No meta-analysis was conducted because of the high heterogeneity of data.


Results: Out of the initial 509 records, only nine studies were included. The risks of bias of individual studies were assessed. Six studies presented data on cost and cost analysis only. The rest three articles provided data on cost-effectiveness. The overall costs of implant overdentures were higher than the conventional complete dentures. However, implant overdentures were more cost-effective when compared to conventional complete dentures. Single-implant overdentures are also less expensive than two-implant overdentures. Overdentures supported by two or four mini-implants were also reported as more cost-effective than conventional two-implant-supported overdentures.

Conclusions: Two-implant-retained overdentures are more expensive but cost-effective than the conventional complete dentures. Two- or four-mini-implant-retained overdentures are less expensive than two-implant-retained overdentures, but there is a lack of long-term data on aftercare cost and survival rate of mini-implants. Single-implant overdentures are also less expensive than the two-implant-retained

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overdentures. The differences of the aftercare costs of different attachment systems for implant overdentures were not significant. There is a need of further studies on comparative cost-effectiveness of different types of implant overdentures.

Keywords: Aftercare costs, attachment systems, conventional complete denture, cost analysis, cost-effectiveness, implant overdenture, mini-implant

INTRODUCTION

Due to the advancement in medical science and better availability of health-care facilities, average human life expectancy is increasing throughout the world. According to the World Health Organization, 72.0 years was the average life expectancy at birth of the global population in 2016. As a result, virtually every country in the world is experiencing growth in the number and proportion of older persons in their population.^[1,2] Considering the fact that a sizeable population of India is aging, it is predicted that the elderly population of the country shall be among the highest in the world by 2025, i.e., 177 million (80% of them residing in rural areas).^[3,4]

Edentulism is a debilitating and irreversible condition and is described as the “final marker of disease burden for oral health.”^[5] Complete edentulism is comparatively much more common among the older age groups than the younger age groups and an edentulous patient may suffer from social, physical, functional and psychological limitations.^[6-8]

Oral rehabilitation by a prosthesis certainly restores masticatory function and appearance of an individual, which leads to improvements in social interaction and quality of life of that person.^[8,9] When it comes to the rehabilitation of patients with complete edentulism, rehabilitation with implant-supported total prosthesis offers greater quality of life benefits than conventional complete dentures.^[10] Although conventional dentures provide less functional efficiency and comfort, their use still remains a valid treatment option in dental clinics, partly because of the higher treatment costs required for dental implants and associated materials, equipment, and surgery.^[11] However, many patients face problems with the adaptation of conventional dentures, especially with the lower one.^[10]

An economic analysis and comparison of alternative health-care interventions should include detailed analysis of initial treatment cost, aftercare costs, and associated clinical time. Apart from cost analysis, cost-effectiveness analysis (CEA) is another method of measuring efficiency of health-care intervention.^[12] A number of studies

have been published, focusing on cost analysis of conventional complete dentures, as well as various types of implant-retained/supported overdentures in patients with mandibular edentulism with or without measuring clinical outcomes. Variations of implant overdentures were due to the varied number of implants used, implant types, and attachment systems used.^[13-21]

The purpose of this systematic review was to analyze the economic implications of various types of implant-supported overdentures and to compare cost-effectiveness with other removable prosthetic treatment options.

MATERIALS AND METHODS

The study protocol was set in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (a 27-item checklist and a four-phase flow diagram).^[22]

The research question was set according to the PICOTS format for clinical questions:

- a. Population: Individuals with completely edentulous lower arch
- b. Intervention: Placement of dental implants for implant-retained/supported overdentures
- c. Comparison
 - Two-implant-retained mandibular overdentures with conventional mandibular complete dentures
 - Two-implant-retained mandibular overdentures with other implant-retained/supported mandibular overdentures including mini-implant-retained overdentures.
- d. Outcomes: Cost analysis and CEA
- e. Time: Up to 10 years of aftercare or follow-up.

Study design

Prospective, retrospective, and randomized clinical trials.

The research question

- Primary question: Is the cost-effectiveness of two-implant-retained mandibular overdentures greater than or at least comparable to that of other removable prosthodontic treatment options?

- Secondary question: What is the difference between the approximate aftercare costs of different removable prosthetic options for lower edentulous arch?

Search strategy

Two electronic databases were searched: PubMed and the Cochrane Central Register of Controlled Trials. It was later complemented by hand-searching.

Following Medical Subject Headings and Boolean operators were used:

- Implant overdentures AND Cost
- Implant retained OR supported prosthesis AND conventional complete dentures
- Implant overdentures AND attachment systems
- Mini-implant retained prosthesis AND cost analysis
- Implant overdentures AND Cost effectiveness.

The systematic review was based on the papers published up to August 31, 2019, without any starting limit. Only articles written in English were considered. The literature search was performed by two independent reviewers (RP and SM). Disagreements between reviewers were solved through discussions.

Inclusion criteria

- Controlled clinical trials and randomized controlled trials
- Individuals with completely edentulous mandibular arch (irrespective of sex)
- The studies should present sufficient data related to the cost and/or cost-effectiveness of removable rehabilitating treatment options of edentulous mandible.

Exclusion criteria

- Case reports, letters, literature reviews, surveys, and willingness-to-pay studies, editorials
- Studies considering implant-supported fixed complete dentures

- Non-English literatures
- Attrition >25% for prospective studies and >50% for retrospective studies
- Unclear sample size and sample characteristics
- Insufficient data.

Data extraction and analysis

Three reviewers (SR, SM, and RP) independently extracted the following data (wherever available): authors, country, years of study, currency, study design, population, sampling criteria, randomization method, number randomized, intervention, outcomes (treatment and aftercare costs,

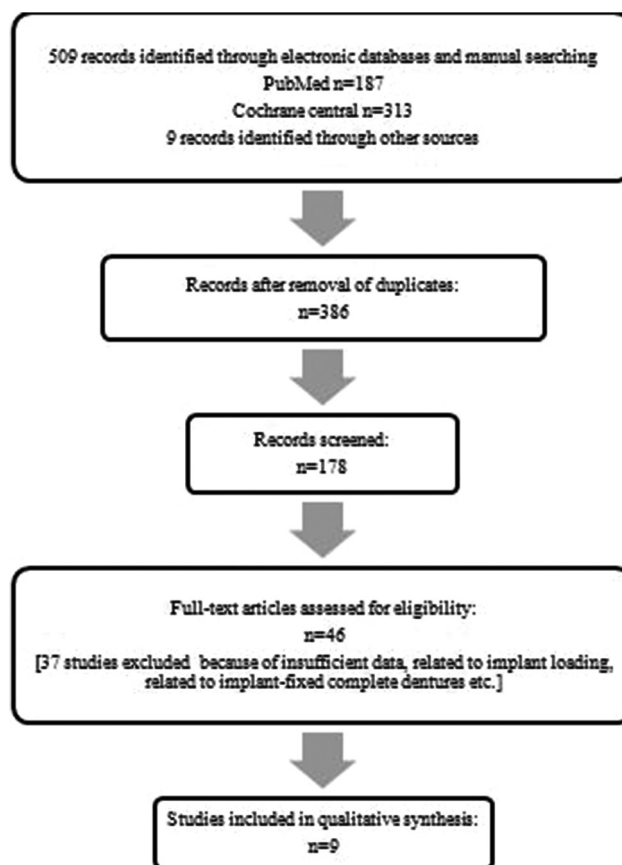


Figure. 1: Study Inclusion Flowchart

Table 1: Risks of bias assessment

Study	Selection bias		Performance bias Blinding of participants and personnel	Detection bias Blinding of outcome assessment	Attrition bias Incomplete outcome data	Reporting bias Selective reporting
	Random sequence generation	Allocation concealment				
van der Wijk et al. (1998)	Low	Low	Low	Low	Low	Low
Takanashi et al. (2004)	Low	Unclear	Low	Unclear	Low	Low
Stoker et al. (2007)	Low	Unclear	Low	Unclear	Low	Low
Walton et al. (2009)	Low	Unclear	High	High	Low	Low
Cristache et al. (2012)	High	High	High	Low	Low	Low
Heydecke et al. (2005)	Low	Unclear	Low	Unclear	Low	Low
Zitzmann et al. (2006)	High	High	High	High	Low	Low
Della Vecchia et al. (2017)	Low	Low	Low	Unclear	Low	Low
Jawad et al. (2017)	Low	High	High	Low	Low	Low

cost-effectiveness, oral and health-related quality of life, and patient satisfaction), follow-up period, and dropout percentage. Disagreement between the authors was resolved through discussion. As considerable heterogeneity was found among the included studies, meta-analysis could not be undertaken. Cochrane risk of bias tool was used for assessing the risk of bias [Table 1].^[23] The studies considering any removable treatment option for completely edentulous population and providing sufficient data on treatment costs in terms of time and money were included in the study.

RESULTS

Out of total 509 initial records obtained through electronic and manual searches, only 46 were selected for complete text review by two independent reviewers (RP and SM). Only nine articles fulfilled all the inclusion criteria to be included in the study [Figure 1]. (Out of 37 rejected articles, 2 were related to implant loading protocol, 9 were comparing implant overdentures with implant-supported fixed prosthesis, 1 study was considering willingness to pay and willingness to accept, 2 were study proposals, and 23 articles did not provide sufficient data required for this study). Out of these nine articles, again only three presented CEA in terms of cost and health outcome (OHIP-20, OHIP-EDENT, or QAPY) along with total treatment costs. Other six presented detailed data on total treatment and/or aftercare costs [Figure 2]. A study by Jawad *et al.*^[21] measured oral health-related quality of life and produced treatment-related costs. However, cost-effectiveness analysis was not done. Summary of the nine selected studies is presented elaborately in Tables 2-7.

DISCUSSION

This systematic review analyzed and compared the costs and/or cost-effectiveness of mandibular implant-retained/

supported overdentures, conventional complete dentures, and mini-implant-retained overdentures.

The 2010 Global Burden of Disease Study report showed the changes in the disability-adjusted life year (DALY) rates for edentulism among all ages and both the sexes from 99/100000 in 1990 to 67/100000 in 2010 (32.6% decline).^[2,5,24] However, there are considerable variations among different countries and populations.^[6] Studies show that edentulism is closely associated with socioeconomic factors and is more prevalent in poor populations and in women. For example, the ratio of edentulism was six times higher in low-income than in high-income Canadian families in 2003.^[25] Untreated edentulism is a serious public health problem, and in a socioeconomically backward population, treatment cost is one important determinant of individual oral health status.^[9] Any treatment modality should be evidence-based and should not be just on the basis of personal beliefs and popular schools of thought.^[26]

Although maxillary and mandibular complete dentures are considered as conventional and standard treatment for complete edentulism, many patients face problems in adaptation, especially in case of lower denture. According to the McGill Consensus, 2002, a two-implant overdenture is the choice of treatment for the edentulous mandible.^[27] Although initial IOD (implant overdenture) treatment costs are higher than those for complete dentures (CDs), improvements in oral health quality of life and patient satisfaction are also typically higher in edentulous patients treated with dental implants.^[9,18,28] The treatment cost analysis helps to understand the cost difference between conventional dentures and implant overdentures during initial treatment and for aftercare. CEA helps to understand the cost-benefit ratio of a treatment modality in terms of health outcome and patient satisfaction.^[20] Multiple studies have reported that implant overdentures are more cost-effective than implant-supported fixed complete dentures.^[29-31] Therefore, in this study, we have concentrated over removable treatment options only. This systematic review intended to identify the most cost-effective implant overdenture treatment option.

The usual denominator in economic analysis of a treatment is years of life gain. However, for a nonfatal condition, it is better to use an index of the disease-specific health-related quality of life.^[28,32] Oral health-related quality of life can be measured with the 20-item oral/health impact profile (OHIP-20), or with OHIP-EDENT, or with quality-adjusted prosthesis years (QAPY).^[18,19,21,33-35] For OHIP-20 and OHIP-EDENT, low scores indicate better quality of life. The study of costs associated with implant

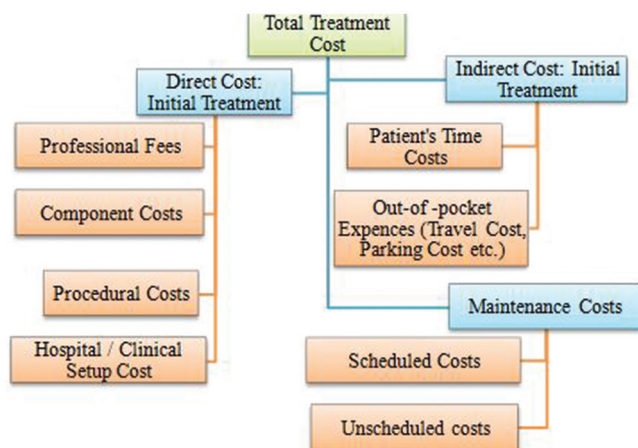


Figure 2: Cost Division

Table 2: Summary of studies analyzing the costs of implant overdentures and other removable prosthodontic treatment options

Study (years)	Setting, currency, follow-up period (months)	Study design	Study description	Outcome reported
van der Wijk et al. (1998) ^[13]	Netherlands, Dutch guilders and then converted into USD (\$ 1=Dfl 1.6); base year 1994,12	RCT	Group 1: (n=89) Each patient received single-bar retained overdenture on 2 permucosal implants (the Branemark system and the IMZ system) Group 2: (n=30) Each patient received transmandibular implants with a superstructure consisted of a triple-bar construction with cantilever extensions Group 3: (n=28) Each patient received conventional CDs after pre-prosthetic surgeries Group 4: (n=89) Each patient received new conventional CDs	Cost and cost analysis
Takanashi et al. (2004) ^[14]	Canada, Canadian dollar; base year 1999, 12	RCT	IOD group (n=30): In each patient, two root form implants (ITI, Straumann) placed between the mental foramina, followed by retentive anchors and gold matrices in the overdenture along with a maxillary conventional CD CD group (n=30): Each patient received upper and lower CDs	Direct and indirect costs
Stoker et al. (2007) ^[15]	Netherlands, Euros €; base year 2000, 96	RCT	Subjects (n=110) treated with one-stage ITI dental implants Group 1: (n=32) In each patient, two-implant-retained overdenture retained with ball attachments (2IBA) and Della Bona matrices was placed Group 2: (n=36) In each patient, two-implant-retained overdenture retained with single egg-shaped Dolder bar (2ISB) was placed Group 3: (n=35) In each patient, four-implant-retained overdenture retained with a triple bar (4ITB) was placed	Aftercare and cost analysis
Walton et al. (2009) ^[16]	Canada, Canadian dollars (1 CAD=1.00 USD, at the time of writing of the article), 12	RCT	Subjects (n=86) were divided into two groups Some (n=42) received single midline implant (ITI, Straumann) with ball attachment for relined conventional dentures Others (n=44) received two implants in mandibular canine regions (ITI, Straumann) with ball attachment for relined conventional dentures	Patient satisfaction, component costs, time and maintenance
Cristache et al. (2014) ^[17]	Romania, Euro €, 60	RCT	Fully mandibular and fully/partially maxillary edentulous patients (n=69) received two screw-type Straumann implants in the mandibular canine region. They received overdentures with 3 types of attachment systems Group B (ball attachments) (n=23) Subgroup B1 - Received retentive anchor with gold matrix ^[14] Subgroup B2 - Received retentive anchor with titanium matrix ^[14] Group M (magnets) (n=23) Group L (locator) (n=23)	Complications, prosthetic success, and costs
Jawad et al. (2017) ^[21]	England, Pound £, 6	RCT	Group MI (n=22): Two mini-implants (2.1 mm diameter × 10 mm length one-piece implant with a square collar and ball abutment) were placed transmucosally (flapless) in the interforaminal region of the edentulous mandible Group CI (n=22): Two conventional (3 mm diameter × 11 mm length) implants were placed in the interforaminal region of the edentulous mandible. These were placed after raising soft tissue flaps and drilling directly into bone. Ball abutments were placed on the conventional implants in a one-stage surgery approach to mimic the mini-implant attachment system	Function (masticatory efficiency etc.), cost, QoL

RCT: Randomized controlled trial, IOD: Implant overdenture, CDs: Complete dentures, QoL: Quality of life

overdentures had been highly heterogeneous. Hence, meta-analysis was not possible.

There was enough evidence to say that the initial costs of implant overdentures were considerably higher than the conventional complete dentures.^[13,34] A study of implant treatment costs in Canada by MacEntee and Walton^[26] reported that implant overdentures with two implants were 7 times costlier than a conventional denture. It was also reported that fixed complete dentures attached to five implants were 17 times more expensive than conventional complete dentures.^[30] Two-implant-supported overdentures were 3.2 times costlier than the conventional complete dentures.^[13] According to one study, overdentures supported by four interconnected implants with a bar required 28% more cost than the overdentures supported by two

interconnected implants with a bar. The difference of costs between a single-bar-retained overdenture and two-ball attachment-retained overdentures was only 4.5%.^[15]

Regarding aftercare, there was very small difference between the long-term aftercare costs of implant-retained overdentures with different attachment systems. However, the implant overdenture patients with ball attachments needed to visit the prosthodontist more often between scheduled checkups to have the retentive system reactivated.^[12] Some studies^[18,36] presented more maintenance costs for implant overdentures than conventional dentures, whereas one study presented less unscheduled costs for implant overdentures than conventional dentures after delivery. Takanashi et al.^[14] also informed that 1-year total follow-up cost (at scheduled visits) was much less for conventional

Table 3: Summary of Studies analyzing the costs of implant overdentures and other removable prosthetic options

Author	Outcome		
	Initial treatment cost	Maintenance or aftercare costs	Total treatment costs
van der Wijk et al. ^[13]	Direct costs were maximum for transmandibular implant-supported overdentures, followed by permucosal implant-supported overdentures and preprosthetic surgeries. Direct initial costs of conventional CDs were much less than other treatment options (\$1058 for CD against \$3441 for 2 permucosal implant-retained overdentures)	Total follow-up costs (through the 1 st year) were very high for IOD groups compared to preprosthetic surgery and CD groups (\$94 for CD group against \$317 for 2 permucosal implant-retained overdenture group). Follow-up costs were least for preprosthetic surgery group (\$59)	Total cost of a transmandibular implant-supported overdenture was seven times more than the cost of a new conventional CD. Permucosal implant-supported overdentures are 3.2 times costlier than the conventional CDs Cost of preprosthetic surgery followed by a CD was almost same as a two-implant-retained overdenture
Takanashi et al. ^[14]		For the period after delivery (P2 to P4; up to 1 year), the direct median cost of unscheduled visits was lower for IODs (\$57) than CDs (\$75), but the difference was not significant. The indirect median cost was also lower for IODs (\$146) than CDs (\$234), and the difference was significant	Total costs of scheduled and unscheduled visits were CD \$ 4,245 for IODs and CD \$ 2,316 for CDs. Total direct cost for an IOD was 2.4 times higher than a CD up to 1 year of prosthesis delivery
Stoker et al. ^[15]		Mean total costs of aftercare (evaluation period 8.3 years) were €997.43+/-620.20 for 2IBA, €961.21+/-460.80 for 2ISB, €984.32+/-436.80 for 4ITB; the differences were nonsignificant (P=0.94)	
Walton et al. ^[16]		Median prosthodontic maintenance time over the 1 st year after implant delivery was almost identical for both groups, approximately 3.3 h (P=0.37). Within the 1 st year of follow-up, 5 patients out of 42 within the single-implant group required retreatment (repair, not replacement). For two-implant group, the number was 2, out of 41 patients	Total component costs (CD \$957.14) of one-implant group were significantly lower than that of two-implant group (CD \$1678.64) over 1 year time. Also surgical time and prosthodontic time and costs were less in single-implant group
Cristache et al. ^[17]	Direct initial cost was highest for the M group, followed by L group, B2 subgroup and B1 subgroup respectively. Overall costs of the M group were significantly higher than the other groups.		Total costs at the end of 5 th year were highest for M group (€2286.34 (SD 224.13)), and lowest for subgroup B1 (€1937.45 (SD 115.89)). Cost of complications per patient after 5 years was significantly higher for the B1 subgroup (€356.16). For subgroup B2, Group M, and Group L, the costs were €67.45, €68.34, and €56.30 respectively Mean NHS costs for MIs were lower than that for CIs (£296 vs. £688). There was a higher mean patient cost observed for the MI group (£193 vs. £156)
Jawad et al. ^[21]		The MI group had higher observed mean unscheduled visits costs (≤78 vs. ≤63)	

IOD: Implant overdenture, CDs: Complete dentures, NHS: National health service

complete dentures against implant overdentures (CD\$20 against CD\$58). The overall treatment costs were higher for two-implant-supported overdentures than single-midline implant-retained overdentures.^[16]

Studies proved that implant overdentures could provide better oral health-related quality of life than the conventional dentures.^[34] According to Heydecke et al.,^[18] implant overdentures required approximately extra 14.41\$ reduce OHIP score by 1. The quality-adjusted prosthesis year (QAPY) is a measure derived from the quality-adjusted life year.^[9] Zitzmann et al.^[19] expressed health outcome in terms of QAPY. From the data reported in their study, cost-effectiveness plane [Figure 3] was constructed to show the incremental cost-effectiveness of implant-retained overdentures and implant-supported overdentures against conventional complete dentures at the end of 3rd year and

10th year of follow-up.^[19,27] Compared to conventional complete dentures, both implant-retained/supported overdentures were expensive treatments but with better oral health outcomes.

Mandibular overdentures, retained by two mini-implants, were less expensive compared to those retained by two standard implants. Even four-mini-implant-retained overdentures were cheaper than conventional two-implant-retained overdentures. OHIP-EDENT scores were less in case of mini-implant-retained overdentures than conventional complete dentures. Mini-implant placement is less traumatic than conventional implants, but failure rate is more. In two-mini-implant-retained overdenture cases, only 28.15 Francs were needed to reduce 1 OHIP score compared to 46.79 Francs for standard two-implant-retained overdenture cases.^[20]

Table 4: Summary of Studies comparing the cost-effectiveness of implant overdentures and other removable prosthetic options, in terms of cost and health outcome

Study (years)	Setting, currency, follow-up period (months)	Study design, health outcome	Study description	Outcome reported, percentage dropout
Heydecke et al. (2005) ^[18]	Canada, Canadian dollar; base year 1999, 12	RCT, OHIP-20	IOD group: Each subject (n=30) received a mandibular overdenture retained by ball attachments on 2 implants (ITI 048.242/243, Straumann, Waldenburg, Switzerland) opposed by a conventional maxillary CD CD group: Each subject received (n=30) maxillary and mandibular conventional CDs	Cost-effectiveness, 20% dropout
Zitzmann et al. (2006) ^[19]	Switzerland, Swiss Francs (CHF 100=US \$61; base year 2000), 36	CCT, QAPY	Group 1: (n=20) Each subject received an implant-retained mandibular overdenture prosthesis on 2 implants and ball abutments Group 2: (n=20) Each subject received a bar-retained overdenture on 4 interforaminal implants (implant supported) Group 3: (n=20) Each subject received a conventional mandibular CD	Cost-effectiveness, 1.67% dropout
Della Vecchia et al. (2018) ^[20]	Brazil, Brazilian currency (1 PPP US\$=1748 BRL) base year 2014, 6	RCT, OHIP-EDENT	Group 1: Each participant received 4 mini-implants (2.0 × 10.0 mm; MDL, Intra-Lock International) for overdenture Group 2: Each participant received 2 mini-implants (2.0 × 10.0 mm; MDL, Intra-Lock International) for overdenture Group 3: Each participant received 2 standard implants (4.0 × 10.0 mm; Morse Lock Straight, Intra-Lock International) + ball abutments for overdenture	Cost-effectiveness, patient satisfaction, 6.67% dropout

OHIP: Oral health impact profile, QAPY: Quality-adjusted prosthesis years, RCT: Randomized controlled trial, CCT: Controlled clinical trial, MDL: Mini Drive-Lock, IOD: Implant overdenture, CDs: Complete dentures

Table 5: Outcome of a study comparing the cost-effectiveness of implant overdentures and other removable prosthetic options, in terms of cost and health outcome

Study	Time horizon, discount rate	Life expectancy (years)	Treatment strategies	Costs (CD \$)*	OHIP score**	ICER
Heydecke et al. ^[18]	1 year, 3%	17.9	IOD	624.88±21.46	31.3±8.3	14.41
			CD	398.57±52.86	47.0±19.7	
	1 year, 5%	17.9	IOD	660.30±24.77	31.3±8.3	15.38
			CD	418.00±61.01	47.0±19.7	

*Equivalent Annual Value for Cost (EAVc), **Equivalent Annual Value for Outcome (EVAo) OHIP: Oral health impact profile, IOD: Implant overdenture, CD: Complete denture, ICER: Incremental cost-effectiveness ratio

Table 6: Outcome of a study comparing the cost-effectiveness of implant overdentures and other removable prosthetic options, in terms of cost and health outcome

Study	Time horizon, discount rate	Treatment strategies	Costs (Swiss Francs)	QAPY	ICER
Zitzmann et al. ^[19]	3 years, 3%	CD	3672	0.82	9100 (ICER1)
		Implant-retained overdentures	8859	1.39	
	10 years, 3%	CD	3879	2.36	3810 (ICER3)
		Implant-retained overdentures	17,822	3.92	
	3 years, 3%	CD	3672	0.82	81,4z82 (ICER2)
		Implant-supported overdentures	17,822	1.50	
10 years, 3%	CD	3879	2.36	22,375 (ICER4)	
	Implant-supported overdentures	18,772	4.33		

QAPY: Quality-adjusted prosthesis years, ICER: Incremental cost-effectiveness ratio, CD: Complete denture

In the field of health science, a cost-effectiveness ratio indicates the additional costs required for each unit of improvement in outcome of an intervention.^[18,27] A cost-effectiveness threshold is generally set, so that the interventions that appear to be relatively good or very good value for money can be identified.^[9,37] There are several types of threshold. In health-related analysis, a willingness-to-pay threshold represents an estimate of what a consumer of health care might be prepared to pay

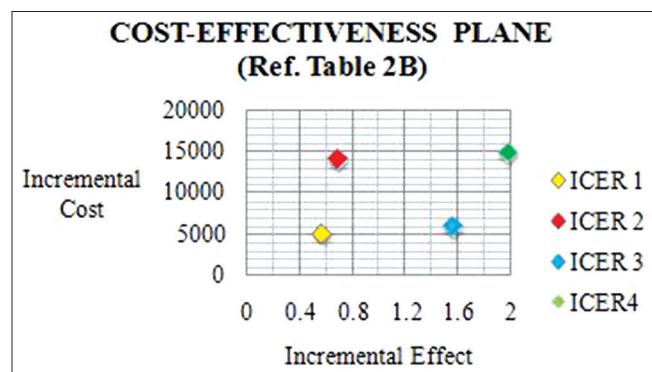
for the health benefit, given other competing demands on that consumer's resources.^[9,37]

The WHO recommendation says interventions that cost less than three times average per-capita income per DALY averted, considered as cost-effective.^[37] However, due to unavailability of data, it is not possible to find out per-QAPY or per-OHIP willingness-to-pay threshold in these studies. It is true that the costs of oral health-care

Table 7: Outcome of a study comparing the cost-effectiveness of implant overdentures and other removable prosthetic options, in terms of cost and health outcome

Study	Group	Treatment Strategies	OHIP-EDENT Score	Incremental costs PPP US \$	Patient satisfaction (100-mm VAS)	ICER
Della Vecchia <i>et al.</i> (2018) ^[20]	Group 1	CD	15.2	510.75	30.3	38.40
		Overdenture	1.9		95.0	
	Group 2	CD	13.9	318.08	34.7	28.15
		Overdenture	2.6		90.0	
	Group 3	CD	17.6	566.13	37.8	46.79
		Overdenture	5.5		84.0	

VAS: Visual analog scale, ICER: Incremental cost-effectiveness ratio, OHIP: Oral health impact profile, CD: Complete denture

**Figure 3:** Cost effectiveness plane obtained from the provided data^[16]

services are huge throughout the world irrespective of any particular country and it is difficult for any public health system to provide assistance for different oral care requirements.

The global spending on dental treatments reached the sum of USD 356.80 billion in 2015.^[9] Hence, it is important for any public health system to use resources allotted for orodental treatments as effectively as possible. Cost analysis and CEA studies can help properly allocate the available resources for better population-based health-care services.^[9,38] Unfortunately, we could not find any study on cost-effectiveness analysis of implant overdentures from Indian context. Hence, there is a huge scope of further research in this field.

CONCLUSIONS

Two-implant-retained overdentures are more expensive treatment options than the conventional complete dentures in terms of initial cost and total cost and than the single-implant-retained overdentures in terms of initial cost. However, there are many studies which confirm that implant-retained overdentures significantly enhance quality of life and chewing efficiency of the edentulous patients. Mini-implants are more cost-effective than two- or four-implant-retained overdentures. However, long-term survival and prognosis of these implants are not yet established. Aftercare cost for implant-retained/supported overdentures with different attachment systems are more

or less comparable with other removable prosthodontic treatment options. However, the cost of a particular treatment is different in different countries and patient's expectations and treatment outcome largely depend on the patient's awareness, treatment quality, availability, etc. There is a lack of literature available on cost and cost-effectiveness of different treatment options for edentulous situations. Economic status of edentulous patients in a population should be considered before formulating a treatment plan. Hence, there is a huge scope of further research on cost and cost-effectiveness of implant overdentures as a treatment option to find out proper cost-benefit ratio.

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Conflicts of interest

There are no conflicts of interest.

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