



Standardizing the evaluation criteria on treatment outcomes of mandibular implant overdentures: a systematic review

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PURPOSE. The aim of this review was to analyze the evaluation criteria on mandibular implant overdentures through a systematic review and suggest standardized evaluation criteria. **MATERIALS AND METHODS.** A systematic literature search was conducted by PubMed search strategy and hand-searching of relevant journals from included studies considering inclusion and exclusion criteria. Randomized clinical trials (RCT) and clinical trial studies comparing attachment systems on mandibular implant overdentures until December, 2011 were selected. Twenty nine studies were finally selected and the data about evaluation methods were collected. **RESULTS.** Evaluation criteria could be classified into 4 groups (implant survival, peri-implant tissue evaluation, prosthetic evaluation, and patient satisfaction). Among 29 studies, 21 studies presented implant survival rate, while any studies reporting implant failure did not present cumulative implant survival rate. Seventeen studies evaluating peri-implant tissue status presented following items as evaluation criteria; marginal bone level (14), plaque Index (13), probing depth (8), bleeding index (8), attachment gingiva level (8), gingival index (6), amount of keratinized gingiva (1). Eighteen studies evaluating prosthetic maintenance and complication also presented following items as evaluation criteria; loose matrix (17), female detachment (15), denture fracture (15), denture relining (14), abutment fracture (14), abutment screw loosening (11), and occlusal adjustment (9). Atypical questionnaire (9), Visual analog scales (VAS) (4), and Oral Health Impact Profile (OHIP) (1) were used as the format of criteria to evaluate patients satisfaction in 14 studies. **CONCLUSION.** For evaluation of implant overdenture, it is necessary to include cumulative survival rate for implant evaluation. It is suggested that peri-implant tissue evaluation criteria include marginal bone level, plaque index, bleeding index, probing depth, and attached gingiva level. It is also suggested that prosthetic evaluation criteria include loose matrix, female detachment, denture fracture, denture relining, abutment fracture, abutment screw loosening, and occlusal adjustment. Finally standardized criteria like OHIP-EDENT or VAS are required for patient satisfaction [*J Adv Prosthodont 2014;6:325-32*]

KEY WORDS: Denture; Overlay; Mandibular prosthesis; Dental implants; Outcome assessment; Patient satisfaction

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INTRODUCTION

Implant overdenture has better quality in its retention and stability than complete denture, and its mastication function is much more effective as well.¹⁻⁴ Especially in mandible, 2-implant overdenture has already been proven as the first choice for edentulous patients through the two conferences (McGill consensus (2002), York consensus (2009)).^{2,5}

Various attachment systems such as ball, bar, and magnet attachment have been used to retain or support the overdenture. The selection of the attachment systems has been mainly depended on the practitioners' personal preference based on their experience and training. Many clinical trials and systematic reviews have tried to evaluate and

compare the attachments in various aspects.⁶⁻⁸ However, previous studies used different criteria or method to evaluate treatment outcomes. In proceeding long-term comparative study, establishing standardized evaluation criteria will help in increasing reliability of the study result by minimizing bias.⁹ There were few reports to suggest a guideline to compare the various attachments and evaluate implant overdenture on edentulous patients.

This systematic review aimed to analyze the evaluation criteria on mandibular implant overdentures through a systematic review and suggest standardized evaluation criteria.

MATERIALS AND METHODS

A systematic literature search was conducted using the combined MeSH terms “mandibular prosthesis” or “Denture, Overlay” and “dental implants” or “dental prosthesis, implant supported” and “clinical study” or “comparative study” or “outcome assessment” or “epidemiologic studies” or “intervention studies” or “patient satisfaction” and limited by “Human” and “English” in the data base, Medical Literature Analysis and Retrieval System Online (MEDLINE). This is to search for all the published data until December 31st 2011 which is relevant to evaluation of mandibular implant overdenture. After searching the combined MeSH terms through internet, the next journals were directly found and the data were added. Clinical Implant Dentistry and Related Research, Clinical Oral Implants Research, Implant Dentistry, International Journal of Oral and Maxillo-facial Implants, International Journal of Oral and Maxillo-facial Surgery, International Journal of Periodontics & Restorative Dentistry, International Journal of Prosthetics, Journal of Clinical Periodontology, Journal of Dental Research, Journal of Oral Implantology, Journal of Oral and Maxillo-facial Surgery, Journal of Oral

Rehabilitation, Journal of Periodontology, Journal of Prosthetics, Journal of Prosthetic Dentistry, and Periodontology 2000.

Among journals which included data on evaluation of implant overdenture until December 2011, randomized and comparative clinical trials between attachments with same number of implants were included. At least one or more evaluation outcomes on implant survival rate, peri-implant tissue, prosthesis, or patient satisfaction should be reported. And intra-osseous implant with root form was only taken into consideration. In addition, a maxillary complete denture was only considered as an opposing prosthesis. Conventional loading was only included. And the articles written in English were included.

However, case reports or technical reports were excluded, and immediate placement of implant after extraction was excluded as well. The case in which follow up duration after the start of function was less than 1 year was excluded. The case in which there were no evaluation criteria of implant treatment outcomes was also excluded. The type with rigid connection such as milled bar or combinations of attachment types, cantilevered applications of attachments was excluded. The case with no abstract was also excluded (Table 1).

Articles were selected by 2 different reviewers based on inclusion and exclusion criteria. 1,159 articles in total were searched and 53 of them were selected through titles and abstracts. And then 29 articles were finally selected through full text reading (Fig. 1). After evaluation items of implant overdenture were listed, they were classified into the following 4 groups. 1) Survival rate of implant, 2) peri-implant tissue evaluation, 3) prosthetic evaluation, 4) patient satisfaction. Each group was classified into subdivisions and evaluated respectively. The items to evaluate peri-implant tissue were classified into plaque index, calculus index, gingival index, bleeding index, probing depth, attachment gin-

Table 1. Inclusion and exclusion criteria for systematic review

Inclusion criteria	
	RCT and clinical trial studies on MIO until December 2011
	Comparative studies between attachments on MIO with same number of implants
	At least one or more evaluation items on implant survival rate, peri-implant tissue, prosthesis or patient satisfaction
	Root form endosseous standard implants
	Upper complete denture
	Conventional loading
	Published in English
Exclusion criteria	
	Case reports or technical reports without statistical comparison
	Study duration less than 1 year of function
	Rigid type of application with milled bar and telescopic abutments
	Combination or cantilevered application of attachments
	Paper without abstract

MIO = Mandibular implant overdenture.

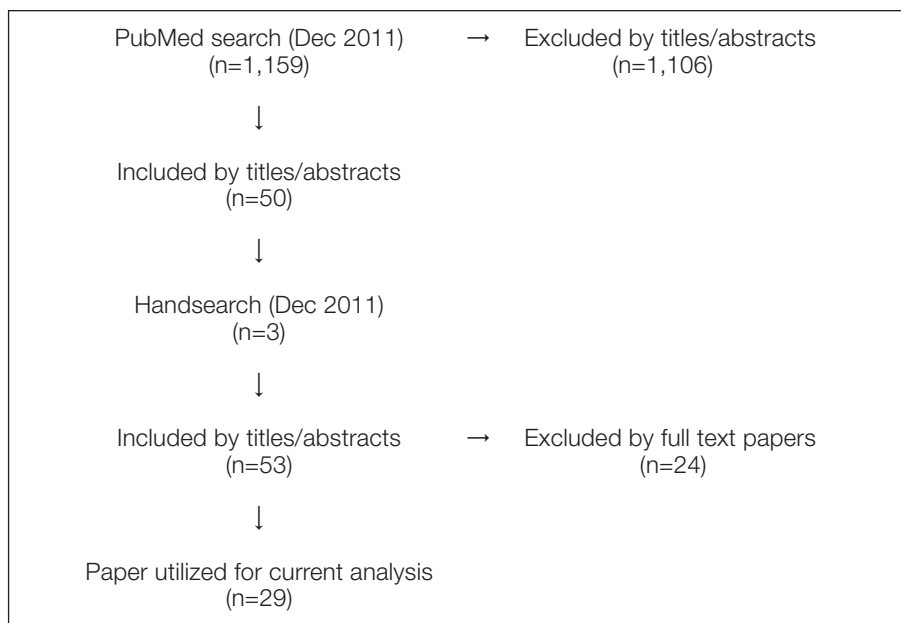


Fig. 1. Flowchart of search strategy.

gival level, amount of keratinized mucosa and marginal bone loss. The items to evaluate prosthesis were classified into abutment screw loosening, abutment fracture, female detachment, loose matrix, denture fracture and occlusal adjustment. The methods measuring patient satisfaction were divided into atypical questionnaire, Visual Analogue Scales (VAS), Oral Health Impact Profile (OHIP). In addition, it was also evaluated whether each method include the following items; overall satisfaction, improved retention, improved stability, chewing ability, speaking ability, appearance satisfaction, food impaction, social function, feeling pain, denture hygiene, denture comfort, easy to getting used, healing satisfaction after surgery.

RESULTS

Twenty nine articles included 21 studies which presented implant survival rate and 17 studies which evaluated periodontal tissue around implant. Also, there were 18 studies which presented prosthetic maintenance and complication, and 14 studies which presented patient satisfaction (Table 2). There were no studies to report cumulative survival rate among any studies reporting implant failure. Seventeen studies evaluating peri-implant tissue status presented following items as evaluation criteria; marginal bone level (14), plaque Index (13), probing depth (8), bleeding index (8), attachment gingiva level (8), gingival index (6), amount of keratinized gingiva (1). In the 18 studies evaluating prosthetic maintenance and complication, the items such as loose matrix (17), female detachment (15), denture fracture (15), denture relining (14), abutment fracture (14), abut-

ment screw loosening (11), and occlusal adjustment (9) were used. Atypical questionnaire (9), VAS (4), OHIP-14 (1) were also used as the format of criteria to evaluate patients satisfaction in 14 studies (Table 3). The each method to evaluate patient satisfaction included following items; Overall satisfaction (11), improved retention (9), chewing ability (9), speaking ability (8), improved stability (5), appearance satisfaction (4), food impaction (2), social function (4), feeling pain (2), denture hygiene (2), denture comfort (1), easy to getting used (1), healing satisfaction after surgery (1)(Fig. 2).

Except for these, there were other studies reporting implant mobility (3), denture retention (3), maintenance cost after treatment (2), and comparing operative time and time which took for prosthesis (1).

DISCUSSION

In evaluating implant overdenture, survival rate of implant, peri-implant aspect, prosthetic maintenance and complication have been commonly used as conventional criteria. However, the methods of evaluating mandible implant overdentures were lack of consistency which might cause researchers to mislead to analyze data from the different studies. To increase reliability, some researchers tried to score on each category by the developed method which was called Delphi method.¹⁶ However, the result was still dependent on their capability and subjectivity.¹⁰ It seems that there was not a common guideline to evaluate implant overdentures.

In this study, any studies reporting at least 1 implant

Table 2. Included papers by inclusion criteria

Study	Year	Study design	Follow-up (y)	Implant type	Type of attachment
Mericske-Stern <i>et al.</i> ²⁰	1994	PS	5	Straumann	Ball (Bonefit), Bar (Bonefit)
Naert <i>et al.</i> ²¹	1994	RCT	3	Nobelbiocare	Ball (Nobelbiocare), Magnet (Dyna), Bar (Dolder bar)
Davis ²²	1996	QRCT	4	Astra	Ball (Gold), Magnet (Nd-Fe-Bo), Bar (Gold)
Davis <i>et al.</i> ²³	1997	QRCT	3	Astra	Ball (Gold), Magnet (Nd-Fe-Bo)
Gotfredsen ²⁴	1997	PS	4.5	Astra	Ball (Astra), Bar (CM rider)
Wismeijer <i>et al.</i> ²⁵	1997	RCT	1.3	Straumann	Ball (Dalla Bona), Bar (Dolder bar)
Naert <i>et al.</i> ²⁶	1997	RCT	3	Nobelbiocare	Ball (Nobelbiocare), Magnet (Dyna), Bar (Dolder bar)
Naert <i>et al.</i> ²⁷	1998	RCT	5	Nobelbiocare	Ball (Nobelbiocare), Magnet (Dyna), Bar (Dolder bar)
Davis and Packer ²⁸	1999	QRCT	5	Astra	Ball (Gold), Magnet (Nd-Fe-Bo)
Naert <i>et al.</i> ²⁹	1999	RCT	5	Nobelbiocare	Ball (Nobelbiocare), Magnet (Dyna), Bar (Dolder bar)
Wismeijer <i>et al.</i> ²⁵	1999	RCT	1.6	Straumann	Ball (Dalla Bona), Bar (Dolder bar)
von Wowern and Gotfredsen ³⁰	1999	RCT/PS	5	Astra	Ball (Astra), Bar (CM rider)
Gotfredsen and Holm ³¹	2000	RCT	5	Astra	Ball (Astra), Bar (CM rider)
Payne and Solomons ⁵	2000	RCT	3	Nobelbiocare	Ball (plastic cap), Bar (Nobelbiocare)
Davis and Packer ³²	2000	PS	3	Astra	Ball (Gold), Magnet (Nd-Fe-Bo), Bar (Gold)
Walton <i>et al.</i> ³³	2002	RCT	1	Nobelbiocare	Ball (Nobelbiocare), Bar (Nobelbiocare)
Walton ³⁴	2003	RCT	3	Nobelbiocare	Ball (Nobelbiocare), Bar (Nobelbiocare)
Assad <i>et al.</i> ³⁵	2004	PS	1.5	Dyna	Magnet (Dyna), Bar (Metal housing)
Naert <i>et al.</i> ³⁶	2004	RCT	10	Nobelbiocare	Ball (Nobelbiocare), Magnet (Dyna), Bar (Dolder bar)
Naert <i>et al.</i> ³⁷	2004	RCT	10	Nobelbiocare	Ball (Nobelbiocare), Magnet (Dyna), Bar (Dolder bar)
Timmerman <i>et al.</i> ³⁸	2004	RCT	8	Straumann	Bar (Dolder bar), Ball (Dalla Bona)
MacEntee <i>et al.</i> ³⁹	2005	RCT	3	Nobelbiocare	Bar (Nobelbiocare round gold bar), Ball (Nobelbiocare ball, titanium cap)
Quirynen <i>et al.</i> ⁴⁰	2005	PS	10	Nobelbiocare	Ball (Nobelbiocare), Magnet (Dyna), Bar (Dolder bar)
Stoker <i>et al.</i> ⁴¹	2007	RCT	8	Straumann	Bar (Dolder bar), Ball (Dalla Bona)
Abd El-Dayem ⁴²	2009	RCT	1.5	Dyna	Cast bar, Prefabricated bar (Dyna)
Cune <i>et al.</i> ⁴³	2010	RCT/CO	10	Friadent	Ball (Friadent), Magnet (Dyna), Bar (Friadent)
Kleis <i>et al.</i> ⁴⁴	2010	RCT/PS	1	BIOMET 3i	Locator (Zest Anchor), Ball (Dal-Ro/O-Ring)
Burns <i>et al.</i> ⁴⁵	2011	RCT/PS	1	Nobelbiocar	Ball (Nobelbiocare), Bar (Nobelbiocare)
Mackie <i>et al.</i> ⁴⁶	2011	RCT	3	Nobelbiocare	Locator (NR), Ball (Southern, Dalla-Bona)

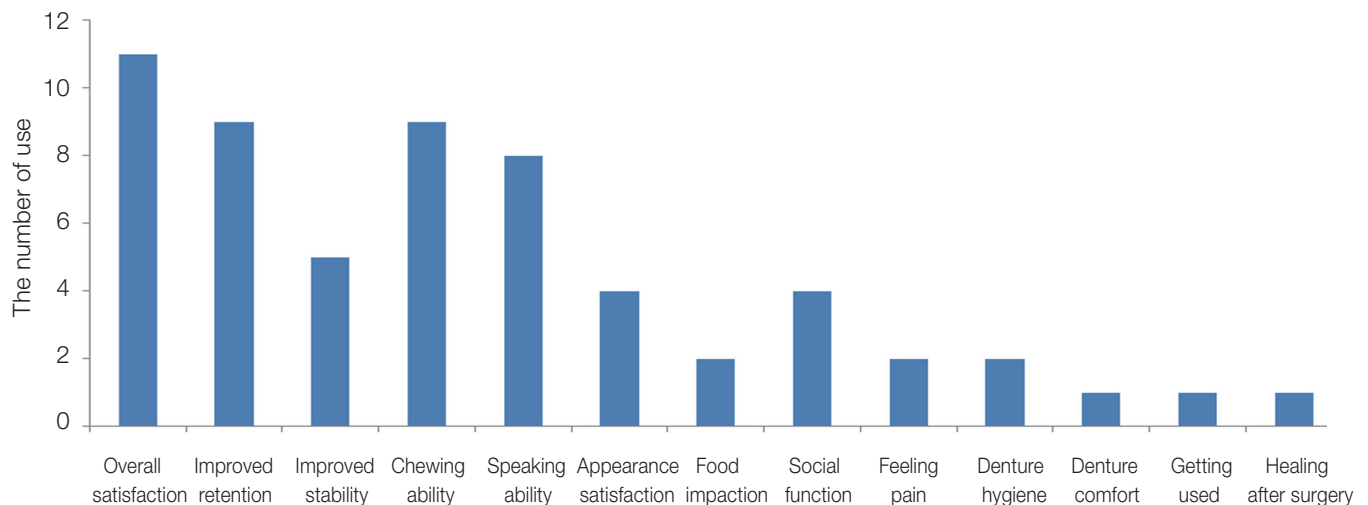


Fig. 2. Items in the questionnaires used to evaluate patient satisfaction on implant overdenture.

Table 3. Treatment outcome index used to evaluate implant survival rate, peri-implant tissue, prosthetic maintenance and complication and patient satisfaction

Study	Year	Implant survival	Peri-implant tissue	Prosthetic maintenance and complication	Patient satisfaction
Mericske-Stern <i>et al.</i> ²⁰	1994	SR	PI, BI, PD, AL	NA	NA
Naert <i>et al.</i> ²¹	1994	SR	PI, BI, PD, AL, BL	SL, AF, FD, LM, DF, DR, OA	AQ
Davis ²²	1997	SR	NA	SL, AF, FD, LM, DF, DR	NA
Davis <i>et al.</i> ²³	1996	SR	PI, BI, BL	SL, AF, FD, LM, DF, DR, OA	AQ
Gotfredsen ²⁴	1997	SR	PI, GI, PD, BL	AF, LM, DF, Hyperplasia	NA
Wismeijer <i>et al.</i> ²⁵	1997	NA	NA	NA	AQ
Naert <i>et al.</i> ²⁶	1997	NA	AL, BL, mucosa complication	SL, AF, FD, LM, DR	NA
Naert <i>et al.</i> ²⁷	1998	SR	PI, BI, AL, BL	NA	NA
Davis and Packer ²⁸	1999	SR	PI, BI, BL	SL, AF, FD, LM, DF, DR, OA	AQ
Naert <i>et al.</i> ²⁹	1999	SR	Mucositis, soreness, ulcer, hyperplasia	NA	AQ
Wismeijer <i>et al.</i> ²⁵	1999	SR	NA	SL, AF, FD, LM, DF, DR	NA
von Wowern and Gotfredsen ³⁰	1999	SR	PI, GI, BL	NA	NA
Gotfredsen and Holm ³¹	2000	SR	PI, GI, PD, BL	SL, AF, FD, LM, DF, DR, OA	AQ
Payne and Solomon ⁶	2000	NA	NA	SL, AF, FD, LM, DF, DR, OA phonetic, Esthetic complaints, lip/cheek biting	NA
Davis and Packer ³²	2000	SR	NA	NA	NA
Walton <i>et al.</i> ³³	2002	SR	NA	FD, LM, DF, DR, OA	VAS
Walton ³⁴	2003	SR	NA	FD, LM	NA
Assad <i>et al.</i> ³⁵	2004	SR	PI, GI, PD, BL	NA	NA
Naert <i>et al.</i> ³⁶	2004	SR	PI, BI, AL, BL	NA	NA
Naert <i>et al.</i> ³⁷	2004	SR	NA	SL, AF, FD, LM, DF, DR, OA	VAS
Timmerman <i>et al.</i> ³⁸	2004	NA	NA	NA	AQ
MacEnteet <i>et al.</i> ³⁹	2005	NA	NA	SL, AF, FD, LM, DF, DR, OA	VAS
Quirynen <i>et al.</i> ⁴⁰	2005	NA	PI, BI, PD, AL, BL	NA	VAS
Stoker <i>et al.</i> ⁴¹	2007	NA	NA	SL, AF, FD, LM, DF, DR, OA	NA
Abd El-Dayem ⁴²	2009	SR	PI, GI, BL	NA	AQ (narrative)
Cune <i>et al.</i> ⁴³	2010	SR	BI, PD, BL	LM, DF, DR	VAS
Kleis <i>et al.</i> ⁴⁴	2010	SR	AL	AF, DF	OHIP
Burns <i>et al.</i> ⁴⁵	2011	SR	PI, GI, PD, AL, KM, BL	FD, LM	AQ (CIP score)
Mackie <i>et al.</i> ⁴⁶	2011	NA	NA	AF, FD, LM, DF, DR	NA

SR=Survival rate; CSR=Cumulative survival rate; PI=Plaque index; CI=Calculus index; BI=Bleeding index; GI=Gingival index; PD=Probing depth; AL=Attachment level; KM=Keratinized mucosa; BL=Bone level; SL=Screw loosening; AF=Abutment fracture; FD=Female detachment; LM=Loose matrices; DF=Denture fracture; DR=Denture relining; OA=Occlusal adjustment; PS=pressure spots; AQ=Atypical questionnaire; VAS=Visual analog scale; CIP=Clinical implant performance; NA=Not available.

failure did not present or describe cumulative implant survival rate. Censored data include patients who are lost to follow up, patients who dropped out, patients who expired from other causes etc.⁹ The more censored patients are, the more influenced the validity of sample size becomes, and also study design itself could possibly lose credibility due to bias.^{9,11} Therefore, cumulative survival rate of implant considering the censored data is significant in evaluation of survival rate of implant for reliability.

A variety of periodontal evaluation criteria were also

applied to evaluate peri-implant tissue. Among them, plaque index was the most frequently used as the evaluation criteria of peri-implant tissue. Both bleeding index and probing depth were the second frequently used. On the other hand, calculus index, which was not reported at all, was a relatively less important evaluation criteria for peri-implant tissue. Not only traditional periodontal index, but sulcus fluid analysis, exudation, and mobility of implant could also be used in examination of tissue around implants.¹² In contrast to the soft tissue evaluation which

was based on the traditional periodontal index, the evaluation of marginal bone loss was lack of consistency due to different reference points.¹³ Nevertheless, plaque index, bleeding index, probing depth, attachment level and marginal bone loss, which were commonly used, might be suggested as minimum criteria to evaluate peri-implant tissue.

Prosthetic complications of mandibular implant overdenture in edentulous patients were varied a lot as: loss of retention, denture relining, fracture of clip/attachment, fracture of denture, fracture of opposing prosthesis, fracture of acrylic resin base, abutment screw loosening, and fracture of abutment screw. The classification of prosthetic outcome which was called six fields table analysis has been already suggested.^{14,15} However, it seemed that a few reports cited the table and prosthetic terminologies such as female and matrix were still confusing. Nevertheless, loose matrix, female detachment, denture fracture, denture relining, abutment fracture, abutment screw loosening, occlusal adjustment were commonly used without large deviation. The prosthetic evaluation criteria might be relatively well-standardized compared to other criteria.

Patient satisfaction can be affected by their subjective recognition of their dentures or by individual difference such as age, gender, and personality.¹⁶ Oral health-related quality of life (OHRQoL) has been used as evaluation criteria for dental prosthesis which could improve mastication and pronunciation, self-esteem and satisfaction on their own appearances.^{17,18} The OHIP which was established as evaluation method for OHRQoL in 1994 has been modified and translated. The unique OHIP-EDENT which specialized to edentulous patients, was recently developed.¹⁹ OHIP-EDENT is composed of 19 questions, and it is divided into 7 sub-groups (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap). VAS could be used as another implement to quantify patient satisfaction with reliability and credibility.⁶ To objectively evaluate patient's subjective satisfaction, psychometric instrument such as a structured questionnaire is desirable to be standardized by OHIP or VAS. In addition, assessment items to evaluate patient satisfaction were suggested to include the following aspects; physiological function (chewing and speaking ability), psychological aspects (overall satisfaction, appearance, and improved retention and stability), and social function.

In summary, the data on cumulative survival rate of implant as evaluation criteria of implant overdenture still seem to be lack in general. Criteria of peri-implant tissue and prosthetic evaluation seem to be relatively well standardized. Also, it seems that the evaluation format to measure patient satisfaction objectively such as OHIP or VAS has not generally used yet.

CONCLUSION

For evaluation of implant overdenture, it is necessary to include cumulative survival rate for implant evaluation. It is

suggested that peri-implant tissue evaluation criteria include marginal bone level, plaque index, bleeding index, probing depth, and attached gingiva level. It is also suggested that prosthetic evaluation criteria include loose matrix, female detachment, denture fracture, denture relining, abutment fracture, abutment screw loosening, and occlusal adjustment. Finally standardized criteria like OHIP-EDENT or VAS are required for patient satisfaction.

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