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Research Article

SUCCESS CRITERIA FOR DENTAL IMPLANT – A LITERATURE REVIEW

*** Dr Sanjay B Lagdive, Dr Rupal J Shah and Dr Himanshu M Vadher**

[1,2,3] **Department of Prosthodontics, Government Dental College, Ahmedabad**

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ABSTRACT

The successful placement of dental implant in todays era dates back to extensive research work of Branemark on dental implantology. Previously osseointegration was solely factor considered to decide the success of implant and its survival in oral cavity. But as we know that many other factors play a keyrole in maintenance of a prosthesis, so such a single factor cannot be evaluated for assessing implant success. Many criterias have been proposed till now but no one is accurate that can be relied upon. This literature review takes acomprehensive look at various factors affecting success of dental implants and the criterias given by researchers for success of dental implant.

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INTRODUCTION

The history of the evolution of dental implants is a rich and fascinating travelogue through time. Since the beginning of mankind, humans have used dental implants in one form or another to replace missing teeth.[1]

Bran mark started comprehensive study on microscopic phenomenon of the bone healing in 1952. He reported the bone contacted on the titanium surface directly.[1] This study led to animal study of end osseous implant. Human study was started in 1965 and he presented the results of 10 years of study in1977.[2] In early development stage of dental implant, it had machined surface without any additional surface treatment. As time went by, scientists have studied and developed the surface, form and shape of implant. As a result, it showed high success rate and predictable results over 40 years and has been utilized for several decades. But also failed implants have been increased as compared with early development stage ofimplant.[2]

During the past decades, careful scientific documentation has provided a solid base for implant therapy as a reliable treatment modality to replace the lost teeth. when performed on the correct indications with proper oral hygiene measures and supportive periodontal care. The role of various factors that would affect the prognosis of dental implants should be carefully considered before attempting to rehabilitate the patients with implants.[3]

MATERIAL AND METHOD

An electronic search was performed via google scholar including the MEDLINE, Pubmed, Citation Index, Web of Science™ Core Collection databases from 1980 to 2018.Studies that were published in English were included in the search

Success and survival in implant dentistry has been evaluated by the survival rate, radiographic crestal bone loss, prosthesis stability and also the presence of peri-implant diseases. Research and technology has made a revolutionary change during the last few years in field of endoosseous implantology.[4]

The individual practitioner and certifying agencies are presented with a bewildering series of choices in determining which implant systems provide an adequate prognosis to warrant their acceptance for clinical use. To make these critical selections, a set of criteria for success based on scientific investigations is essential.[5]

Consideration should be given to evaluating the following criteria: 1) durability, 2) bone loss, 3) gingival health, 4) pocket depth, 5) effect on adjacent teeth, 6) function, 7) esthetics, 8) presence of infection, discomfort, paresthesia or anesthesia, 9) intrusion on the mandibular canal, 10) patient emotional and psychological attitude and satisfaction."The availability of sound scientific clinical criteria for determining long-term host acceptance of functioning dental implants is long overdue.

Corresponding author:* **Dr Sanjay
Department of Prosthodontics, Government Dental College, Ahmedabad

Although these may be valid criteria for evaluation, they are somewhat inadequate because guidelines are not given for the values to be recorded in each criterion.

Previous criteria for success of endosseous implants have been proposed by Schnitman and Shulman, Cranin *et al*. McKinney *et al*, and Albrektsson *et al*. Although their criteria include most of the possible concerns in implant success, the supporting documentation for some of these criteria is not compelling.[5]

The following parameters should be evaluated for implant success.

Pain

Most clinical implant positions in the literature do not invade the structures of the infraorbital or inferior alveolar nerves. Pain should not be associated with the implant after healing. When present, it is more often an improper fitting prosthetic component, or pressure on the soft tissue from the prosthesis. Percussion and forces up to 500 g (1.2 psi) may be used clinically to evaluate implant pain or discomfort. Percussion is used for the impact force to the implant, not for the audible effect associated with integration.[6]

Mobility

Clinical research on osseointegration indicates that when mobility occurs the implant becomes tender to percussion or pressure, the mobility continues to increase, and the removal of the implant is required. mobility of an implant has been traditionally examined by finger or instrument pressure. Two concepts have resulted from this type of mobility testing. one concept is that successful implants are immobile and any detected mobility indicates failure. The other concept is that some degree of mobility (usually 1 mm or less) is acceptable Thus mobility is a definitive sign of certain failure.Findings are subjective and difficult to duplicate.

Today, the clinical term "lack of mobility" may be used to describe implant movement, and is a clinical condition most often used to determine as to whether the implant is integrated. Lack of clinical movement does not mean the true absence of mobility. A healthy implant may move less than 75micromt; yet, it appears as zero clinical mobility. [6]

According to Schulte, the Periotest dynamically measures mobility by percussing the tooth four times per second with an electronically controlled rod. The result or Periotest value (PTV) obtained represents a measure of mobility.

Study of Assessment of oral implant mobility done by hugo Chavez states that implant mobility is attributed primarily to the damping like character of the bone/ implant interface. The in vivo project established a range of mobility with a Periotest value of -6 to +2.[7]

For this reason and the evidence cited, the absence of mobility is an important criterion for implant success.

Peri-Implant Radiolucency

A complete peri-implant radiolucency indicates the presence of soft tissue and probable Implant mobility and is a predictor of impending implant loss.

Marginal Bone Loss

The level of the crestal bone may be measured from the crestal position of the implant at the initial implant surgery. Several studies report yearly radiographic marginal bone loss after the first year of function in the range of 0 to 0.2 mm. Clinical studies often report statistical average bone loss—not the range of bone loss observed in the study. Each implant should be monitored as an independent unit when assessing bone loss for a clinical evaluation of success, survival, or failure. Clinical observations obtained by probing or radiographic measurements of 0.1 mm for bone loss are operator sensitive and are not reliable.

Therefore, the Pisa Consensus in this report suggests that the clinical assessment for each implant monitors marginal bone loss in increments of 1.0 mm. The bone loss measurement should be related to the original marginal bone level at implant insertion, rather than to a previous measurement (*e.g.*, 1year prior). The most common method to assess the marginal bone loss is with a conventional periapical radiograph. Computer-assisted image analysis and customized x-ray positioning devices may be superior methods of measuring bone loss,17 but are not required for the criteria established at this consensus.[6]

Stability of bone support for the implant is important criteria for determining success. Without relative stability of the level of bone, implant is doomed to fail. Adell et el determined that the mean bone loss for Branemark osseointegrated implants is 1.5 mm for the first year, followed by a mean bone loss of 0.1 mm per year. This value was confirmed by Cox and Zarb with their 3-year report showing a mean bone loss of 1.6 mm for the first year and a mean of 0.13 mm in subsequent years.

Sulcus and Probing Depth

Nearly all implants can be probed to within 1 to 2 mm of the level of the bone. The sulcus depth does not appear to be related to soft tissue response or stability of the bone level. It is possible to maintain a stable bone level with a sulcus depth considered to be greater than normal for natural teeth.[5]The benefit of probing the implant sulcus has been challenged in the literature because sound scientific criteria are lacking. Increasing probing depths over time may indicate bone loss, but not necessarily indicate disease for an endosteal implant Probing pressures are subjective, as is the angulation of the probe next to an implant crown. The "correct pressure" for probing has not been defined for implants, but may be less important than with teeth, because there is no connective tissue attachment zone next to an implant. Sulcus depths greater than 5 to 6 mm around implants have a greater incidence of anaerobic bacteria and may require intervention in the presence of inflammation or exudate (e.g., surgery, antibiotic regimens). Probing not only measures pocket depth, but also reveals tissue consistency, bleeding, and the presence of exudate.[6]Thus, in implants, sulcus depth is neither a good predictor of problems with stability of bone level nor a useful parameter for evaluating implant success. Future research in the area of probing is needed before including this as a primary criteria in a consensus for success, survival, and/orfailure[6]

Gingival Status

Information, suggests that although an increasing degree of gingival inflammation is not a desirable response, it has not shown to be a factor in implant success. Even If gingival inflammation progressed to bone loss, this is much better evaluated by testing mobility and evaluation of bone loss with a standardized radiographic technique.[5]The GI has been modified and adapted (mGI) for application around oral implants by Mombelli *et al*, while a simplified GI has been proposed by Apse and associates. Indices used to assess marginal mucosal conditions around oral implants are presented in Table 1.[8]

Table 1

Score	Mombelli et al[40] (mGI)	Apse et al[50]
0	No bleeding when a periodontal probe is passed along the mucosal margin adjacent to the implant	Normal mucosa
1	Isolated bleeding spots visible	Minimal inflammation with color change and minor edema
2	Blood forms a confluent red line on mucosal margin	Moderate inflammation with redness, edema, and glazing
3	Heavy or profuse bleeding	Severe inflammation with redness, edema, ulceration, and spontaneous bleeding without probing

Damage to Adjacent Teeth

Although an implant that is impinging on adjacent roots could not be considered successful even though the implant and the tooth survived, this problem is one of iatrogenic origin. Incorrect placement is a complication reflecting the skill and judgment of the operator who placed the implant and should not be used as a criterion for implant success.

Violation of the Maxillary sinus, Mandibular canal, or floor of the Nasal Cavity

Implants penetrating the maxillary sinus or floor of the nasal cavity have a decreased percentage of success. For the Branemark implant this was found to be 70% to 72% in a 5 and 10-year follow-up. Penetration of the maxillary sinus or nasal cavity is often done intentionally by the surgeon when the quantity of bone is deficient. This condition should therefore not be considered a criterion for success. Impingement on the mandibular canal has not been studied, but when it occurs it is a serious complication requiring immediate action by the clinician. However, impingement is also an iatrogenic, complication and should be considered separately in computing the percentage of success. Its presence is not the result of the implant material or design.

Appearance

Blomberg found that although satisfaction was high, appearance was the most common cause of dissatisfaction with osseointegration restorations. To be considered a success, an implant must allow placement of a restoration with adequately esthetic appearance.

Persistent Infection

Implants that are the source of persistent or recurrent infections should not be considered successful. With some implant designs, the implant may be held in place despite this problem. However, this situation should not be considered healthy, and implants that are so involved are considered failures.

Length of Service

Length of service is an important criterion for success because most implant modalities are highly successful for 1 or 2 years after placement. The previously proposed criteria of 75% success after 5 years as proposed by Schnitman and Schulman is no longer adequate. It has been made obsolete by the results reported by Adell *et al* and Cox and Zarb. These results indicate that a 5-year success rate of 87.5% to 96.5% at the symphysis of the mandible is attainable, with a 10-year success rate of 93%. In the maxillae, a success rate of 81% to 82% is also attainable after 5 to 10 years.

Below are presented the various success criterias for implant given by researchers based on their studies.

Schnitman and Schulman, 1979

1. Mobility less than 1 mm in any direction
2. Radiologically observed radiolucency graded but no success criterion defined
3. Bone loss no greater than one third of the vertical height of the bone
4. Gingival inflammation amenable to treatment; absence of symptoms and infection, absence of damage to adjacent teeth, absence of paresthesia and anesthesia or violation of the mandibular canal, maxillary sinus,or floor of the nasal passage Functional service for 5 years in 75% of patients

Crainin, Silverbranch, Sher, and Salter, 1982

1. In place 60 months or more
2. Lack of significant evidence of cervical saucerixation on radiographs
3. Freedom from hemorrhage according to Muhleman's Index
4. Lack of mobility
5. Absence of pain or percussive tenderness
6. No pericervical granulomatosis or gingival hyperplasia
7. No evidence of a widening peri-implant space on Radiograph

McKinney, Koth, and Steflik.s, 1984

Subjective Criteria

1. Adequate function
2. Absence of discomfort
3. Patient belief that esthetics and emotional and psychological attitudes are improved

Objective Criteria

1. Good occlusal balance and vertical dimension
2. Bone loss no greater than one third of the vertical height of the implant, absence of symptoms, and functionally stable after 5 years
3. Gingival inflammation vulnerable to treatment
4. Mobility of less than 1 mm buccolingually,mesiodistally, and vertically
5. Absence of symptoms and infection associated with the dental implant

6. Absence of damage to adjacent tooth or teeth and their supporting structures
7. Absence of paresthesia or violation of mandibular canal, maxillary sinus, or floor of nasal passage Healthy collagenous tissue without polymorphonuclear infiltration

Success Criterion

Provides functional service for 5 years in 75% of implant patients

Albrektsson, Zarb, Worthington, and Erickson,G 1986

1. Individual unattached implant that is immobile when tested clinically
2. Radiograph that does not demonstrate evidence of peri-implant radiolucency
3. Bone loss that is less than 0.2 mm annually after the implant's first year of service
4. Individual implant performance that is characterized by an absence of persistent and/or irreversible signs and symptoms of pain, infections, necropathies, paresthesia, or violation of the mandibular canal
5. ln context of criteria mentioned, a success rate of 85%at the end of a 5-year observation period and 80% at the end of a l0-year observation as a minimum criterion for success

Further, in 1998 Esposito *et al*.7,9 have listed out the various criteria for success which were agreed upon at the 1st European Workshop on Periodontology.

According to them following were to be considered success criteria for osseointegrated implants –

Absence of mobility

An average radiographic marginal bone loss of less than 1.5 mm during the first year of function

Less than 0.2 mm annually thereafter,
Absence of pain/parasthesia

It was also suggested that probing depths related to a fixed reference point and bleeding on probing should be measured. Several authors have expressed many criteria to assess the success of a functional implant. The success criteria, which were initially targeted for evaluation as 5 years survival has changed. With the improved technology and understanding of the tissue behaviour the criteria are set with a target of 10-year survival rate.

The ICOI Pisa Implant Quality of Health is based on clinical evaluation. This scale allows the dentist to evaluate an implant using the listed criteria, place it in the appropriate category of health or disease, and then treat the implant accordingly. Three primary categories were established by the Consensus: success, survival, and failure. The success category describes optimum conditions, the survival category describes implants still in function but not with ideal conditions, and the failure of an implant represents an implant that should be or already has been removed. There are 4 implant groups to describe the clinical conditions of success, survival, or failure (Table 2).[5]

Table 2

Table 1. Health Scale for Dental Implants*

Implant Quality Scale Group	Clinical Conditions
I. Success (optimum health)	a) No pain or tenderness upon function b) 0 mobility c) <2 mm radiographic bone loss from initial surgery d) No exudates history
II. Satisfactory survival	a) No pain on function b) 0 mobility c) 2–4 mm radiographic bone loss d) No exudates history
III. Compromised survival	a) May have sensitivity on function b) No mobility c) Radiographic bone loss >4 mm (less than 1/2 of implant body) d) Probing depth >7 mm e) May have exudates history
IV. Failure (clinical or absolute failure)	Any of following: a) Pain on function b) Mobility c) Radiographic bone loss >1/2 length of implant d) Uncontrolled exudate e) No longer in mouth

DISCUSSION

Implant success is as difficult to describe as the success criteria required for a tooth. A range from health to disease exists in both conditions.[6]Each criteria has its own consideration to be evaluated in order to determine success. The primary criteria for assessing implant quality, or health are pain and mobility at the implant level.[4,6] The presence of either one greatly compromises the implant and removal usually is indicated. Suppuration and probing depth are the frequently used criteria at peri-implant soft tissue level.

Routine probing depths are not suggested in the absence of other signs or symptoms and may be related to the presence of local disease or pre-existing tissue thickness before the implant was inserted.Bone loss is most often evaluated with radiographs, which only monitor the mesial and distal marginal bone next to the implant.[6]

As for prosthetic level, the commonly used criteria include function and esthetics while patient's satisfaction is commonly considered a success if comfort and appearance satisfaction are achieved. The reported success rate consistently decreased when the number of parameters included for the assessment of success was increased.[4]

Implant failure is easier to describe than implant success or survival and may consist of a variety of factors. Any pain, vertical mobility, and uncontrolled progressive bone loss warrant implant removal.[6]

CONCLUSION

To evaluate the implant success, a clinician should strictly adhere to anyone of the success criterias given. one must measure or record the required criteria sunder strict aseptic condition and evaluate them appropriately otherwise a minor deviation of the measurement may affect the evaluation of implant success according to the criteria which is being followed.

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