Implant Success, Survival, and Failure: The International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference

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S uccess criteria for endosteal implants have been proposed previously by several authors[1–6] The report by Albrektsson et al[4] is widely used today. However, it does not consider the amount of crestal bone lost during the first year. In addition, success rates suggested in this guideline describe an ideal implant quality of health for a study or clinical report, but does not address individual implants that may have a stable condition in the mouth after a brief episode of bone loss.

The success criterion most commonly reported in clinical reports is

The primary function of a dental implant is to act as an abutment for a prosthetic device, similar to a natural tooth root and crown. Any success criteria, therefore, must include first and foremost support of a functional prosthesis. In addition, although clinical criteria for prosthetic success are beyond the scope of this article, patient satisfaction with the esthetic appearance of the implant restoration is necessary in clinical practice.

The restoring dentist designs and fabricates a prosthesis similar to one supported by a tooth, and as such often evaluates and treats the dental implant similarly to a natural tooth. Yet, fundamental differences in the support system between these entities should be recognized. The purpose of this article is to use a few indices developed for natural teeth as an index that is specific for endosteal root-form implants. This article is also intended to update and upgrade what is purported to be implant success, implant survival, and implant failure. The Health Scale presented in this article was developed and accepted by the International Congress of Oral Implantologists Consensus Conference for Implant Success in Pisa, Italy, October 2007. (Implant Dent 2008;17:5–15)
Key Words: implant clinical success, implant clinical survival, implant clinical failure

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the survival rate, meaning whether the implant is still physically in the mouth or has been removed.[7] Proponents of this method say it provides the clearest presentation of the data. Critics argue that implants that should be removed because of pain or disease may be maintained and are wrongfully reported as being successful.

A natural tooth is not described in the literature as clinical success or failure. Instead, ideal conditions for a tooth are reported, and a quality of health scale is used to describe intraoral clinical conditions. In 1993, an implant quality of health scale was established by James and further developed by Misch.[8,9] On 5th October,

2007, a Pisa, Italy Consensus Conference (sponsored by the International Congress of Oral Implantologists) modified the James–Misch Health Scale and approved 4 clinical category that contain conditions of implant success, survival, and failure. Survival conditions for implants may have 2 different categories: satisfactory survival describes an implant with less than ideal conditions, yet does not require clinical management; and compromised survival includes implants with less than ideal conditions, which require clinical treatment to reduce the risk of implant failure. Implant failure is the term used for implants that require removal or have already been lost.

The term implant success may be used to describe ideal clinical conditions. It should include a time period of at least 12 months for implants serving as prosthetic abutments. The term early implant success is suggested for a span of 1 to 3 years, intermediate implant success for 3 to 7 years, and long-term success for more than 7 years. The implant success rate should also include the associated prosthetic survival rate in a clinical report.

CLINICAL INDICES

Periodontal indices are often used for the evaluation of dental implants.[10,11] Periodontal indices, of themselves, do not define implant success or failure. These clinical indices must be related to other factors such as exudate or overloading of the prosthesis. However, understanding the basis of a few clinical indices for evaluation allows these criteria to establish a health-disease implant quality scale related to implant therapy.

Pain

Most clinical implant positions in the literature do not invade the structures of the infraorbital or inferior alveolar nerves. Therefore, in the success-to-failure criteria, it is assumed that the implant does not violate the major nerves of the jaws.[12,13] Subjective findings of pain or tenderness associated with an implant body are more difficult to assess than these conditions with natural teeth.

Once the implant has achieved primary healing, absence of pain under vertical or horizontal forces is a primary subjective criterion. 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. Usually, pain from the implant body does not occur unless the implant is mobile and surrounded by inflamed tissue or has rigid fixation but impinges on a nerve.

Pain during function from an implant body is a subjective criterion that places the implant in the failure category. Sensitivity from an implant during function may place the implant in the survival criteria, and may warrant some clinical treatment.

Mobility

Rigid fixation is a clinical term for implants, which describes the absence of observed clinical mobility with vertical or horizontal forces under 500 g, similar to evaluating teeth. Osseointegration is a histologic term defined as the surrounding bone in direct contact with an implant surface at the magnification of a light microscope.[12] Over the years, rigid fixation and osseointegration have been used interchangeably. 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. A root-form implant supported prosthesis is most predictable with this type of support system.

Lack of clinical movement does not mean the true absence of mobility. A healthy implant may move less than 75 μm; yet, it appears as zero clinical mobility.[14] Clinical lack of implant mobility does not always coincide with a direct bone–implant interface.[3] However, when observed clinically, lack of mobility usually means that at least a portion of the implant is in direct contact with bone, although the percentage of bone contact cannot be specified.[15] A clinically mobile implant indicates the presence of connective tissue between the implant and bone, and suggests clinical failure for an endosteal root-form implant. Implant "mobility" may be assessed by computer or various instruments,[16,17] but at this point in time these instruments are not necessary to determine clinical movement in a horizontal or vertical direction as being implant failure.

Radiographic Crestal Bone Loss

The marginal bone around the implant crestal region is usually a significant indicator of implant health. The level of the crestal bone may be measured from the crestal position of the implant at the initial implant surgery. The most common method (in the literature) to asses bone loss after healing is by radiographic evaluation. Of course, conventional radiographics only monitor the mesial or distal aspect of bone loss around the implant body.

Several studies report yearly radiographic marginal bone loss after the first year of function in the range of 0 to 0.2 mm.[18–20] The marginal bone loss for the quality of health scale should include the first year. Although there are many different aspects that contribute to early bone loss, regardless of the cause the overall amount of bone loss may affect clinical criteria of success to failure. Clinical studies often report statistical average bone loss—not the range of bone loss observed in the study. If 1 implant of 10 loses 5 mm of bone, the average bone loss in the study is 0.5 mm; yet, the range of bone loss was 0 to 5 mm. 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.*, 1 year prior).

The most common method to assess the marginal bone loss is with a conventional periapical radiograph. Although this only determines the mesial and distal bone loss, it is a time-tested method. 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.

Probing Depths

Probing depths around teeth are an excellent proven means to assess the past and present health of natural teeth, but probing depths around implants may be of little diagnostic value, unless accompanied by signs (*e.g.*, radiographic radiolucencies, purulent

exudate, bleeding) and/or symptoms (*e.g.*, discomfort, pain). 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. Stable, rigid, fixated implants have been reported with pocket depths ranging from 2 to 6 mm. Lekholm *et al*[20] found that the presence of deep pockets was not accompanied by accelerated marginal bone loss. Healthy, partially edentulous implant patients consistently exhibit greater probing depths around implants than around teeth.

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. The potential for damage to the fragile attachment or marring of the implant surface may exist during probing.[3] On the other hand, there is no clinical or experimental evidence supporting this hypothesis.[21] Future research in the area of probing is needed before including this as a primary criteria in a consensus for success, survival, and/or failure.

On the other hand, charting the attachment level in implant permucosal areas does aid the dentist in monitoring these regions. Probing to monitor implants has been suggested in several implant workshops and position articles.[22–25] Sulcus depths greater than 5 to 6 mm around implants have a greater incidence of anaerobic bacteria[26–28] 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.[29]

It is of benefit to probe and establish a baseline measurement after the initial soft tissue healing around the permucosal aspect of the implant. Increases in this baseline measurement over time most often represents marginal bone loss. In the presence of other signs and/or symptoms, the probing depth compared with the baseline measurement may be diagnostic in a clinical evaluation.

Although routine probing healthy implants on a regular basis seems unwarranted, a baseline measurement and probing in the presence of other symptoms and/or signs is indicated. As such, in the ICOI Pisa Consensus Criteria, probing depths are not assessed in the success or satisfactory health conditions, but are included in the compromised survival condition.

Peri-implant Disease

The term peri-implantitis describes the bone loss from bacteria around an implant.[30] Peri-implantitis is defined as an inflammatory process affecting the tissue around an implant in function that has resulted in loss of supporting bone.[28] Bacteria, on occasion, may be the primary factor for bone loss around an implant. Anaerobic bacteria have been observed in the sulcus of implants, especially when probing depths are greater than 5 mm.[27]

Stress-induced bone loss (*e.g.*, overloading the bone implant interface) occurs without bacteria as the primary causative agent.[31–34] However, once the bone loss from stress or bacteria deepens the sulcular crevice and decreases the oxygen tension, anaerobic bacteria may become the primary promoters of the continued bone loss. In other words, the bacteria involved in peri-implatitis may oftentimes be secondary to one of the prime causative factors, such as overloading the bone–implant interface.

Exudate or an abscess around an implant indicates exacerbation of the peri-implant disease and possible accelerated bone loss. An exudate persisting for more than 1 to 2 weeks usually warrants surgical revision of the peri-implant area to eliminate causative elements. The reduced bone height, after the exudate episode, makes the implant more prone to secondary occlusal trauma. Therefore, the dentist must reevaluate stress factors for the new bony condition and often must reduce them to improve long-term performance.

The ICOI Pisa Implant Quality of Health Scale

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 1).

Group I represents success and is considered optimum health conditions. No pain is observed with palpation, percussion, or function. No clinical implant mobility is noted in any direction with loads less than 500 g. Less than 2.0 mm of radiographically crestal bone loss is observed compared with the implant insertion surgery. The implant has no history of exudate. The prognosis of Group I implants is very good to excellent.

Group II implants are categorized as "survival" and have satisfactory health. They are stable, but show a history of, or potential for, clinical problems. No pain or tenderness is observed on palpation, percussion, or function. No observable mobility exists with loads less than 500 g. Radiographic crestal bone loss is between 2.0 and 4.0 mm from the implant insertion. The prognosis is good to very good, depending on the stable condition of the crestal bone.

Group III implants are also in the "survival" category, but exhibit a slight to moderate peri-implantitis and compromised health status. Group III implants are characterized by no pain in function. No vertical or initial horizontal mobility is evident. Greater than 4 mm radiographic crestal bone loss has occurred since implant placement, but bone loss is less than 50% from around the implant. Probing depths have increased from baseline up to one-half the length of the im-

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

*International Congress of Oral Implantologists, Pisa, Italy, Consensus Conference, 2007.

plant, often accompanied with bleeding on probing. Exudate episodes (if present) may have lasted more than 2 weeks. The prognosis is good to guarded, depending on the ability to reduce and control stress once the surgical corrections have improved the soft and hard tissue health.

The Group IV of the Pisa Implant Health Scale is clinical or absolute failure. The implant should be removed under any of these conditions: (1) pain on palpation, percussion or function, (2) horizontal and/or vertical mobility, (3) uncontrolled progressive bone loss, (4) uncontrolled exudate, or (5) more than 50% bone loss around the implant. Implants surgically placed but unable to be restored (sleepers) are also included in Group IV failure. Regardless of whether the implant is still in the mouth or removed, the implant is recorded in this category as a failure in all statistical data. Implants that have exfoliated or have been surgically removed are also in this failure category.

SUMMARY

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. The primary criteria for assessing implant, quality, or health are pain and mobility. The presence of either one greatly compromises the implant and removal usually is indicated. Routine probing depths are not suggested in the absence of other sings or symptoms and may be related to the presence of local disease or preexisting 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.

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.

The ICOI Pisa Consensus Conference has simplified and updated a Health Scale specific for endosteal implants and included categories of success, survival, and failure. In addition, these categories of health may be related to the prognosis of the existing conditions.

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Tabelle 1. Gesundheitstechnische Einteilung für Zahnimplantate

Qualitätsstaffelung für Implantate* Gruppe	Klinische Bedingungen
I Erfolg (Optimaler Gesundheitszustand)	a) Keine Schmerzen oder Empfindlichkeiten bei Aufnahme der Funktionalität b) 0 Mobilität c) < 2 mm radiographisch festgestellter Knochengewebsverlust nach orster Operation d) Keine Exsudathistorie
II Zufrieden stellende Überlebensrate	a) Keine Schmerzen bei Funktionsaufnahme b) 0 Mobilität c) 2 – 4 mm radiographisch festgestellter Knochengewebsverlust d) Keine Exsudathistorie
III Beeinträchtige Überlebensrate	a) Eventuell auftretende Sensitivitäten bei Funktionsaufnahme b) Keine Mobilität c) Radiographisch festgestellter Knochengewebsverlust >4 mm (weniger als die Hälfte des Implantatkörperumfangs) d) Sondierungstiefe >7 mm e) Eventuell vorliegende Exsudathistorie
IV Versagensfälle (Klinisches oder absolutes Versagen)	Einer der nachfolgenden Grunde: a) Auftreten von Schmerzen bei Funktionsübernahme b) Mobilität c) Radiographisch festgestellter Knochengewebsverlust >1/2 der Länge des Implantats d) Unkontrolliertes Exsudat e) Nicht mehr im Mundraum vorhanden

* Internationaler Kongress der Oralimplantologen, Pisa, Italien, Übereinstimmungsbildende Konferenz, 2007.

Tabla 1. Escala de salud para implantes dentales

Escala de calidad de los implantes* Grupo	Situación clínica
I Exitoso (óptimo estado de salud)	a) Sin dolor ni sensibilidad después de funcionar b) 0 movilidad c) pérdida ósea de <2 mm a partir de la cirugía inicial d) Sin antecedentes de exudados
II Supervivencia satisfactoria	a) Sin dolor después de funcionar b) 0 movilidad c) pérdida ósea de 2 a 4 mm d) Sin antecedentes de exudados
III Supervivencia comprometida	a) Posible sensibilidad después de funcionar b) Sin movilidad c) Pérdida ósea de > 4mm (menos de la mitad del cuerpo del implante) d) Profundidad de > 7 mm e) Posibles antecedentes de exudados
IV Fracasó (Fracaso clínico o absoluto)	Cualquiera de los siguientes: a) Dolor después de funcionar b) Movilidad c) Pérdida ósea de > 1/2 del largo del implante d) Exudado sin control e) Ya no se encuentra en la boca

* Congreso Internacional de Implantólogos Orales, Pisa, Italia, Conferencia de Consenso 2007.

Tabela 1. Escala de Saúde para Implantes Dentários

Escala de Qualidade de Implante* Grupo	Condições Clínicas
I Sucesso (Saúde ótima)	a) Sem dor ou maciez durante atividade b) 0 mobilidade c) <2 mm perda de osso radiográfico a partir da cirurgia inicial d) Sem história de exsudatos
II Sobrevivência Satisfatória	a) Sem dor durante atividade b) 0 mobilidade c) 2 – 4 mm perda de osso radiográfico d) Sem história de exsudatos
III Sobrevivência Comprometida	a) Pode ter sensibilidade durante atividade b) Sem mobilidade c) Perda de osso radiográfico >4 mm (menos que 1/2 de corpo de implante) d) Profundidade da sondagem >7 mm e) Pode ter história de exsudatos
IV Falha (Falha clínica ou absoluta)	Qualquer dos seguintes: Dor durante atividade b) Mobilidade c) Perda de osso radiográfico >1/2 extensào do implante d) Exsudatos nào-controlados e) Nào mais na boca

* Congresso Internacional de Implantologistas Orais, Pisa, Itália, Conferência de Consenso, 2007.

Таблица 1. Шкала оценки качества дентальной имплантации

Шкала качества имплантации* Группа	Клинические состояния
I Успешная имплантация (Оптимальное здоровье)	a) Отсутствие боли или чувствительности при функционировании b) Отсутствие подвижности c) Радиографическая оценка потери костной массы <2 мм после первой операции d) Отсутствие экссудации
II Удовлетворительная приживаемость	a) Отсутствие боли при функционировании b) Отсутствие подвижности c) Радиографическая оценка потери костной массы 2 – 4 мм d) Отсутствие экссудации
III Отягощенная приживаемость	a) Возможна чувствительность при функционировании b) Отсутствие подвижности c) Радиографическая оценка потери костной массы >4 мм (менее имплантата) d) Глубина прощупывания >7 мм e) Возможна экссудация
IV Неудачная имплантация (Клиническая или абсолютная)	Любое из нижеследующего: a) Боль при функционировании b) Подвижность c) Радиографическая оценка потери костной массы >1/2 длины имплантата d) Неуправляемая экссудация e) Отсутствие в ротовой полости

* Международный конгресс зубных имплантологов, Пиза, Италия, Интегративная конференция, 2007.

Tablo 1. Dental İmplantlar için Sağlık Ölçeği

İmplant Kalite Ölçeği* Grup	Klinik Koşullar
I Başarı (Optimum sağlık)	a) Fonksiyonda ağrı veya acı yok b) 0 hareketlilik (mobilite) c) ilk cerrahiden beri radyografik kemik kaybı: <2mm d) Eksuda öyküsü yok
II Tatmin Edici Sağkalım	a) Fonksiyonda ağrı yok b) 0 hareketlilik c) 2 - 4 mm'lik radyografik kemik kaybı d) Eksuda öyküsü yok
III Sağkalımda Bozukluk	a) Fonksiyon sırasında hassasiyet olabilir b) Hareketlilik yok c) Radyografik kemik kaybı >4 mm (implant gövdesinin 1/2'inden daha az) d) Prob derinliği >7 mm e) Eksuda öyküsü olabilir
IV Başarısız (Klinik veya Kesin başarısızlık)	Aşağıdakilerin herhangi biri: a) Fonksiyon sırasında ağrı b) Hareketlilik c) Radyografik kemik kaybı: implant uzunluğunun >1/2'inden fazla d) Kontrol edilemeyen eksuda e) Ağızda yerleşik değil

* Oral İmplantolojistlerin Uluslararası Kongresi, Pisa, İtalya, Ortak Görüş Konferansı, 2007.

表1
デンタルインプラント　ヘルススケール

インプラント　クォリティスケール* グループ	臨床コンディション
I 成功 (最適健康状態)	**a)** ファンクションで無痛または触痛皆無 **b)** 弛緩動揺ゼロ **c)** 初回手術以後レントゲン上骨吸収<2mm **e)** 滲出物病歴無し
II 満足感の得られる存続状態	**a)** ファンクションで無痛 **b)** 弛緩動揺ゼロ **c)** レントゲン上骨吸収2–4mm **d)** 滲出物病歴無し
III 妥協した存続状態	**a)** ファンクションで多少の触痛 **b)** 弛緩動揺は見られない **c)** レントゲン上骨吸収>4mm (インプラント本体½以下) **d)** プロービングの深さ>7mm **e)** 滲出物病歴の可能性
IV 失敗 (臨床または完全失敗)	下記のどれかに該当: **a)** ファンクションで痛感 **b)** 弛緩動揺 **c)** レントゲン上骨吸収 > ½ インプラント本体 **d)** 滲出物コントロール不可能 **e)** 口腔内不在

* 口腔インプラント学国際学術会議、開催地イタリア、ピサ
2007年度コンセンサス　カンファレンス

表 1
牙科植體健康量表

植體品質量表*

組別	臨床狀況
1 成功 (最理想的健康狀態)	a) 作用時不會感到疼痛或壓痛 b) 零移動性 c)初步手術後 X 光攝影骨質流失 < 2mm d) 無滲出物病史
2 狀況良好	a) 作用時不會感到疼痛 b) 零移動性 c) 骨質流失 2 - 4 mm d) 無滲出物病史
3 狀況普通	a) 作用時敏感 b) 零移動性 c) X 光攝影骨質流失 > 4mm（小於植體體部 ½） d) 探測深度 > 7mm e) 可能有無滲出物病史
4 失敗 (臨床或絕對失敗)	下列任一： a) 使用時會疼痛 b) 移動性 c) X 光攝影骨質流失 > 植體長度 ½ d) 無法控制的滲出物 e) 已經不存在口中

* 義大利比薩 – 國際植牙專科醫師學會 2007 共識會議

표 1
치과용 임플란트의 건강 상태 척도

임플란트 품질 척도*

군	임상 조건
I 성공적 (최적의 상태)	a)사용시 통증이나 압통 없음 b)움직임 0 c)최초 수술에서 방사선 촬영 시 < 2 mm 골 소실 d)삼출물 병력 없음
II 만족스런 생존	a) 사용 시 통증 없음 b) 움직임 0 c) 방사선 촬영 시 2 - 4 mm의 골 소실 d) 삼출물 병력 없음
III 타협적 생존	a) 사용 시 민감하게 반응할 수 있음 b) 움직임 없음 c) 방사선 촬영 시 > 4 mm의 골 소실(임플란트 몸체의 1/2 이하) d) 탐침 깊이 > 7 mm e) 삼출물 병력 있을 수 있음
IV 실패 (임상 또는 명백한 실패)	하기 항목 해당 시: a) 사용 시 통증 있음 b) 움직임 있음 c) 방사선 촬영 시 임플란트의 > 1/2 길이의 골 소실 d) 삼출물 통제 안됨 e) 구강 내 있지 않음

* 이태리 피사(Pisa) 국제 구강 임플란트 전문의 학회(International Congress of Oral Implantologists) 2007년 합의 회의(Consensus Conference)