A 4- to 6-Year Retrospective Clinical Study of Cracked Teeth Restored with Bonded Indirect Resin Composite Onlays

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Purpose: The purpose of this study was to retrospectively evaluate the clinical performance of bonded indirect resin composite onlays for the treatment of painful, cracked teeth over a 6-year period. ***Materials and Methods:*** Forty-three posterior teeth diagnosed as having a crack were selected in the restorative department of the University of Genoa. Inclusion criteria were sensitivity to biting and cold and a clinically visible crack. Direct composite buildup after removal of the existing restoration was performed before definitive cavity preparation. All composite onlay restorations were cemented with an adhesive technique using a 3-step total etch system and a dual-cure composite cement. Patients were interviewed and clinically examined at 1 week, 4 weeks, and every 6 months. ***Results:*** The effectiveness of bonded onlay restorations was evaluated for a mean observation time of 4.78 years. At 1 week, 38 (88.37%) restored teeth were free of pain, 3 (6.98%) still had sensitivity to cold, and 2 (4.65%) still had sensitivity to cold and chewing. At 4 weeks, 40 (93.02%) teeth were free of pain, 2 (4.65%) still had sensitivity to cold and chewing, and 1 (2.32%) needed endodontic treatment. Two other teeth (4.65%) also needed endodontic treatment, the first after 2 months and the second after 5 months. During the evaluation period, 3 restorations (6.98%) failed, and upon clinical examination, 40 (93.02%) teeth were free of symptoms with a 6-year survival rate of 93.02% (life table analysis). ***Conclusions:*** Bonded indirect resin composite onlays can be successful in treating painful, cracked teeth. From the findings of this study, it appears that cuspal protection should be incorporated into the design of coronal restorations. *Int J Prosthodont 2007;20:609–616.*

The term *cracked tooth* was first described by Richey et al[1] and Cameron[2,3] as an incomplete fracture of a vital posterior tooth that involves the dentin and occasionally extends to the pulp. A more recent attempt to define the nature of this condition described it as a "fracture plane of unknown depth and direction passing through tooth structure that, if not already involving, may progress to communicate with the pulp and/or periodontal ligament."[4]

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Epidemiologic data reveal that splits or fractures are the third most common cause of tooth loss in industrialized countries.[5] This finding indicates that cracked tooth syndrome is of high clinical importance. The condition presents mainly in patients aged between 30 and 50 years; men and women are equally affected.[6,7] Cracked teeth were found most frequently in the maxillary molars, followed by maxillary premolars and mandibular molars.[5,6] The cause of cracks in teeth is complex and multifactorial. Statistical correlation between etiologic factors and incomplete fractures of teeth, especially asymptomatic cracks in teeth, could not be located in the current literature.[8] The most commonly identified etiologic factors are structural design of cavity preparations, occlusal and parafunctional forces, and trauma.[9–11] Rosen[10] identified iatrogenic causes, including deep and extensive cavity preparation and poorly designed casting or inappropriate use of pins. Ratcliff et al[8] suggests that intracoronal restora-

tions put teeth at a 29 times greater risk for cracks. However, cracks can occur in teeth along development fissures with or without an occlusal restoration.[11,12] Hiatt[9] suggested a relationship between occlusal habits and incomplete fracture of teeth and also discussed the wedging effect of cusp-fossa relationships. As described by Rattcliff et al,[8] excursive interferences and parafunction may be precursors to cracks in restored teeth. Occlusal forces misdirected over the surface of the tooth combined with chewing may produce severe stresses that can violate the elastic limits of dentin. Finally, teeth become more brittle with age and therefore more susceptible to cracking and fracture, especially if the tooth has been restored with an intracoronal restoration.

This dental condition has a set of signs and symptoms that occur together to create the so-called cracked tooth syndrome.[3] Pain on biting that ceases after the pressure has been withdrawn is a classic sign.[10,13] The primary symptom is a momentary lancinating pain caused by the micromovement of the cracked dentin surfaces as occlusal forces are initiated and released during chewing, or when objects such as a pencil or pipe are placed between the teeth.[10] Symptoms can be elicited when pressure is applied to an individual cusp.[6] Patients complain of extremely acute pain when pressure is applied on only some occlusal aspects of the tooth.[14] Pain increases as the occlusal force increases, and relief occurs once the pressure is withdrawn, though some patients may complain of symptoms after the force on the tooth has been released.[11,13] Patients may have difficulty in identifying the affected tooth, because there are no proprioceptive fibers in the pulp. The tooth is not normally tender to percussion in an axial direction, and radiographic observations mostly show nothing on any area of the tooth or root. The patients complain of tooth sensitivity to thermal changes, especially to cold and to sugar-containing foods.[14,15] The use of magnified vision, whether with surgical loupes or intraoperatory microscopes, may enhance the early diagnosis of cracks in dentition with no restoration or with existing restorations, although there are few peer-reviewed articles to instruct the clinical practitioner about the significance of cracks and the involvement of the pulp.[8] Clinical observation has shown that most cracks are superficial, involving only part of the coronal portion of the tooth and a slight amount of root structure. Some more complex cracks, however, involve the dental pulp or the intraradicular portion of the root. Diagnosing the severity of a cracked tooth is nearly impossible[14]; however, with pulpal involvement, the clinical signs are those of pulpitis and apical periodontitis rather than dentinal sensitivity.[10,15]

The literature offers several treatment options for painful, cracked teeth. Occlusal adjustment can lead to immediate relief of symptoms. As a temporary diagnostic treatment, the cementation of a stainless steel orthodontic band was recommended to stabilize the involved tooth.[6,10,13] A high success rate has been reported when full-coverage acrylic resin provisional crowns were used to stabilize the compromised tooth. In both cases, the tooth should be examined after 2 to 4 weeks, and if symptoms of irreversible pulpitis are evident, endodontic treatment should be performed.[13,15]

A bonded resin composite restoration with or without cuspal coverage as a definitive restoration has the potential to connect the weakened cusps with the restoration material. Adhesive procedures may prevent microleakage along the crack line.[6] A scanning electron microscopy (SEM) investigation demonstrated that all symptomatic cracks in teeth appear to be extensively contaminated by bacteria.[16] In vitro studies suggest that adhesive bonded resin composite restorations can improve the strength of structurally compromised teeth.[17,18] In a clinical study, overlaying the cusps with amalgam or composite was successful in most cases.[19] In a 6-month clinical investigation, Opdam and Roeters[20] found no statistically significant difference in the results of teeth treated with a bonded resin composite restoration with and without cuspal coverage. Direct and indirect bonded resin composite has been described as a successful restorative treatment of cracked teeth.[20–22] However, some authors do not agree with this and recommend that cracked teeth, especially those with wide cavities, should be protected and strengthened by full cuspal coverage. Protection and permanent stabilization can be achieved with a full-coverage crown.[6,14,15] According to Behle,[23] recent advances in dentin bonding technology, ceramic systems, and composite restorative materials allow conservative direct resin restorations, indirectly fabricated composite restorations, or ceramic inlay and onlay restorations rather than the aggressive removal of sound tooth structure for a full-coverage crown restoration.

Most clinical longitudinal studies of bonded composite restorations in the treatment of cracked teeth published to date are of limited duration.[20] The aim of this retrospective longitudinal study was to document the efficacy of treating painful, cracked teeth with bonded indirect resin composite onlays over up to 6 years.

Materials and Methods

Study Population

Between November 2000 and November 2006, 43 laboratory-fabricated composite onlays were placed. The study population comprised 43 patients (17 female, mean age: 36.8 years, range: 20 to 66 years; and 26 male, mean age: 38.3 years, range: 19 to 65 years) who

presented with a toothache. All patients reported pain when chewing and tooth sensitivity when cold beverages and food came in contact with the teeth. Only a few patients were able to localize the sensitive tooth. All teeth in this clinical investigation had amalgam restorations. The clinical investigation was performed with a thermal test using a cotton pellet soaked with ethyl chloride. All cusps were randomly tested with Tooth Slooth crack detector (Professional Results) by placing the plastic biting device in the central fossa and having the patient occlude and release. A positive response was recorded when the patient experienced pain or discomfort upon loading or release of pressure.

The examination was performed with the use of 4.3 × 400 surgical head-worn loupes (KS, Carl Zeiss Vision). Cracks were detected clinically by direct vision and transillumination. Only a few cracks were detected visually after the removal of the existing restoration. Articulated diagnostic casts mounted in a semiadjustable articulator (SAM 3, SAM Präzisionstechnik) with a facebow transfer and centric relation record were made for every patient in the study. Condylar inclination was set with a protrusive record. An examination of facets on the occlusal surfaces and eccentric interferences were recorded for all posterior teeth. In addition, photographs and radiographs of all cracked teeth were taken.

All patients were informed about the design and goal of the study and provided written consent. In addition, they all agreed to an observation period of more than 5 years with at least 2 recall visits per year. The study protocol was approved by the Ethics Committee of the University of Genoa, Faculty of Medicine.

Clinical Procedures

For each restoration, the shade was determined before starting any clinical procedure. Isolation was performed with rubber dam. An interim direct resin composite restoration was performed as a core buildup before onlay cavities were prepared.

Under local anesthesia, the existing amalgam restoration was removed using a diamond bur in a high-speed handpiece with 3-point water spray. If needed, a metal matrix was placed and fixed with interdental wooden wedges. After secondary caries removal, the cavities were etched for 15 seconds with 37% phosphoric acid (Total Etch, Ivoclar Vivadent), rinsed for 20 seconds, and gently air dried for 3 seconds. Next, a 3-component dentin adhesive system (Ecusit PrimerMono, DMG) was applied according to the manufacturer's recommendations and light cured for 20 seconds. The cavities were first pre-restored with a resin composite buildup using a hybrid composite (Ecusit Composite, DMG). The resin composite was placed in increments not exceeding 2 mm in thickness and each increment was cured for 40 seconds. A halogen light-curing unit with an intensity of 800 mW/cm^2 (Spectrum 800, Dentsply) was used. After the removal of the wedges and matrix, the composite buildup was post-cured for 40 seconds from the buccal and lingual sides. The pre-reconstruction allowed a constant and minimum depth of the cavity preparation. Box-shaped onlay cavities were prepared. An 80-µm diamond bur was used for gross preparation, followed by smoothing of all preparation margins with a 25-µm diamond finishing bur. The cavity design followed the preparation guidelines for indirect onlay restorations: all enamel supported by sound dentin, distinct finishing lines, and all internal angles and edges rounded. The minimum box depth was 1.5 mm; however, occlusal boxes were often within a range of 1.5 to 3.0 mm. The involved cusp(s) were reduced by about 1.5 to 2 mm. When the isthmus preparation exceeded one half of the distance from the central fossa to the cusp tip, a restoration with cuspal coverage was considered. No bevel was placed along the margins. If possible, all margins were placed within enamel and preferably located supragingivally.

As for the equigingival and intracrevicular margins, gingival displacement was obtained using a retraction cord (Ultrapack, Ultradent). No displacement was needed in the supragingivally prepared teeth.

Following cord retraction, the final full-arch impression was taken using a polyether material (Permadyne or Impregum, 3M ESPE) or polyvinyl siloxane (Honigum, DMG); the single impression–double mixing technique was used. An irreversible hydrocolloid (Kromopan 100, Lascod) impression of the opposing dentition was made, interocclusal bite registrations were recorded, and a facebow was used to relate the master casts to the semiadjustable articulator (SAM 3). A direct provisional restoration was placed with a matrix band using a light-cured semiflexible material (Fermit, Ivoclar Vivadent), and the occlusion was inspected.

The laboratory-processed onlays were fabricated with microhybrid indirect resin composites (Sculpture and Sculpture Plus, Pentron Technologies). Under rubber dam, all restorations were luted applying the adhesive technique as follows. Upon removal of the provisional restoration, the tooth was cleaned with pumice on a rotating prophylaxis brush (Pellex and Nylon brush, Hawe Dental). At the try-in stage, the individual onlays were assessed for proximal contacts, contour, marginal adaptation, and shade match. Enamel margins were etched with 37% phosphoric acid (Total Etch) for 30 seconds and dentin for 15 seconds, followed by a thorough 10-second rinsing with water and gentle air drying for 3 seconds. Then a 3-component dentin adhesive system (Ecusit PrimerMono, DMG) was applied according to the

Table 1 Characteristics of the 43 Cracked Teeth

Characteristic	Cracked teeth (%)
Gender	
Male	26 (60.47)
Female	17 (39.53)
Extent of existing amalgam restoration	
Class I	7 (16.28)
Class II, 2 surfaces	13 (30.23)
Class II, 3 surfaces	19 (44.19)
Onlay	4 (9.30)
Tooth	
Premolar	7 (16.28)
Molar	36 (83.72)
Arch	
Maxilla	25 (58.14)
Mandible	18 (41.86)

manufacturer's recommendations and light cured for 20 seconds. The internal surfaces of the onlays were silanized with a prehydrolized silane solution (Monobond S, Ivoclar Vivadent), and a thin layer of bonding resin was applied but not light cured. A dual-cure, low-viscosity composite cement was used as the luting material (Variolink, Ivoclar Vivadent). Excess cement was removed with a brush and dental floss interproximally. The restorations were marginally covered with glycerine gel to avoid oxygen inhibition of the composite surface. Each proximal line angle, marginal ridge, and occlusal aspect of the onlays was separately light cured with an energy density of 800 mW/cm^2 (Spectrum 800, Dentsply). After rubber dam removal, the margins were finished with a scaler and fine-grit diamond bur to remove excess resin, followed by Soflex disks (3M ESPE). Occlusion was evaluated, and excursive interferences in lateral, lateroprotrusive, and protrusive excursions were removed. All restorations were placed by the authors in the restorative department of the University of Genoa using the same materials and adhesive procedures.

All patients received hygiene instructions, and complete plaque removal by mechanical scaling and root planing was performed every 3 to 12 months. Photographs, radiographs of the restorations, and data forms were used as documentation tools. After 1 week, all patients were contacted by the authors via telephone and asked if they still experienced tooth sensitivity to cold foods and beverages or pain upon loading the tooth. Furthermore, patients were asked if the level of pain had become more severe, had diminished, or had remained the same. At 4 weeks, this interview was repeated. Patients were examined clinically by the authors at the oral hygiene recalls. Interviews were repeated and the treated teeth were tested according to the same protocol used during the diagnostic procedure. When there was no difference between the restored tooth and adjacent teeth, the cracked tooth was considered symptom-free.

Statistical Analysis

The resin composite onlays were defined as either a success or failure according to the following criteria: success was the positive, censored event, whereas failure was defined as the negative, uncensored event. Based on this definition, survival rates were calculated using a nonparametric survival analysis (Kaplan-Meier). The observation time for a restoration started with the date of cementation, which was determined from the patient's record. The end of the observation time for a successful restoration corresponded to the reevaluation date. The end of observation for a failed restoration was the date when this event was noted in the record or when the failed restoration was detected during the reevaluation appointment. The statistical analysis was performed to determine the success rate with the software SPSS Version 11.0 (SPSS).

Results

A total of 43 indirect resin composite onlays were placed for the treatment of painful, cracked teeth over a 6-year period. The effectiveness of the treatment with bonded restorations was evaluated for a mean observation time of 4.78 years. All restorations were fabricated by 2 dental technicians separately according to the manufacturer's instructions. All patients could be followed during the recall period. All teeth in this clinical investigation had amalgam restorations. The locations of all cracked teeth and the extent of the existing amalgam restorations are listed in Table 1.The most frequently involved teeth in this study were molars, with 36 onlay restorations (83.72%).

Figures 1 to 8 present a clinical case of a painful cracked maxillary first molar with a Class I amalgam restoration restored with a bonded indirect resin composite onlay. Table 2 and Fig 9 show the clinical performance of bonded indirect resin composite onlays for the treatment of painful, cracked teeth over a period of 6 years.

At 1 week, 38 (88.37%) restored teeth were reported to be completely free of symptoms, and 5 (11.63%) still had symptoms: 3 (6.98%) patients had sensitivity to cold and 2 (4.65%) had sensitivity to cold and chewing. No patients were only sensitive to chewing. At 4 weeks, 40 (93.02%) teeth remained vital and were free of symptoms and 2 (4.65%) still had sensitivity to cold and chewing. No patients were only sensitive to chewing.

After the third week, 1 patient (2.32%) needed endodontic treatment at a second mandibular molar. In this patient, the algic symptoms were spontaneous and severe. After endodontic access was performed, an incomplete fracture line was observed by means of surgical loupes. After the endodontic treatment, the

Fig 1 Maxillary first molar with a Class I amalgam restoration and a crack at the mesial marginal ridge.

Fig 2 After amalgam removal, a crack at the complete mesial marginal ridge can be observed.

Fig 3 Composite buildup.

Fig 4 Onlay preparation with complete cuspal coverage.

Fig 5 Impression taking using silicon material.

Fig 6 Final indirect resin composite restoration.

Fig 7 *(left)* Resin composite onlay luted with the adhesive technique.

Fig 8 *(right)* Restoration after 5 years of service.

Table 2 Clinical Performance of Bonded Indirect Resin Composite Onlays (n) for the Treatment of Painful, Cracked Teeth

	Baseline	1 wk	5 wk	4–6 y*
Sensitive to cold and biting	43	2	2	0
Sensitive to cold	0	3	0	0
Sensitive to biting	0	0	0	0
Endodontic treatment (failure)	0	0	1	3
No symptoms	0	38	40	40

*Mean: 5.12 y.

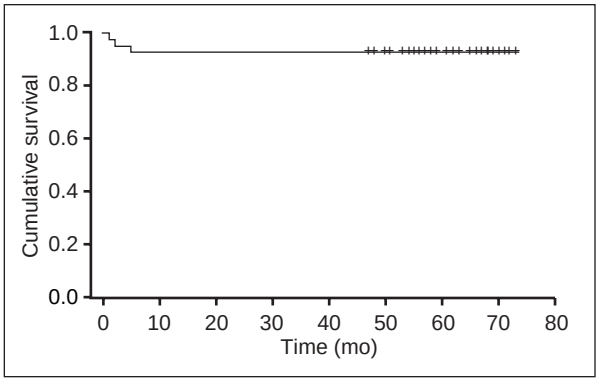

Fig 9 Kaplan-Meier survival curve.

patient reported no pain. The tooth was then restored with a full-crown restoration. Two other teeth (4.65%) also needed endodontic treatment, the first after 2 months and the second after 5 months. Both teeth were maxillary molars and the onlays were replaced with a full-crown restoration.

During the evaluation period, 3 restorations (6.98%) failed, and upon clinical examination, 40 (93.02%) teeth were vital and free of symptoms, with a 6-year survival rate of 93.02% (life table analysis). No restoration failed because of marginal infiltration, fracture, or debonding, and no teeth were lost for periodontal reasons. Superficial marginal discoloration was sometimes associated with a decrease in marginal integrity and was observed in 5 restorations (11.63%). During the study period, periodontal treatment procedures including deep scaling and root planing, as well as surgical pocket elimination, were needed in 6 patients. These criteria for clinical evaluation were not included in the longitudinal study.

Discussion

Clinical studies are needed to evaluate the performance of restorative materials and techniques, because certain intraoral conditions cannot be reproduced in the laboratory. Retrospective studies may provide a reliable picture of the clinical performance of both materials and techniques.

The aim of the present study was to assess the clinical effectiveness of bonded indirect resin composite onlays to restore painful, cracked teeth. A failure rate of 6.98% with an estimated 6-year survival rate of 93.02% for 43 onlay restorations is favorable. The results of this retrospective clinical study demonstrate that bonded indirect resin composite onlays may represent a successful method of treating painful, cracked teeth.

The cracked tooth should be treated by stabilizing the crack and preventing its expansion with both circumferential fixation and occlusal protection. Previous studies suggest that teeth with cracks should be restored with adequate cuspal protection.[6,14,15] A full-coverage crown or onlay restoration best satisfies this objective.[14,22]

Ratcliff et al[8] demonstrated that there is a chronicity and that certain combinations of etiologic factors, such as existing intracoronal restorations and parafunction, increase the likelihood of crack propagation. In the literature, the significant extent of cuspal flexure caused by large intracoronal cavity preparations is well described.[18,24] Cuspal deflection may represent an etiologic factor that contributes to the propagation of cracks. It is mandatory to avoid the propagation of the crack by means of an adequate restoration. In vitro investigations demonstrated the effectiveness of intracoronal adhesive bonding restorations in reducing cuspal deflection during simulated occlusal loading.[18,24] A 6-month clinical investigation established the effectiveness of bonded composite to restore painful, cracked teeth.[20] The results of that study suggest that direct composite restorations without cuspal coverage were indicated, while cuspal coverage was unnecessary. Indirect resin composite or ceramic inlay restorations for the treatment of cracked tooth syndrome have been described, but no longitudinal data confirm the effectiveness of these restorations.[21,22] Whether bonding between the cracked tooth structure and the restoration is strong enough to withstand the forces applied on functionally loaded teeth in the long-term is questionable. As a restorative goal, cavities should be prepared as conservatively as possible; however, as proposed by Opdam and Roeters,[20] it is possible that the covered cusps will exhibit greater longevity compared to direct resin composite restorations. For clinical treatment of painful, cracked teeth, the choice to protect the cusps will sacrifice a small

amount of sound tooth structure to avoid the possible risk of crack propagation and tooth fracture in the long-term.

An indirect restoration needs a provisional restoration. This factor can increase the risk for pulpal complications.[20] In this study, an interim direct resin composite restoration was performed pretreatment to protect the pulp and avoid cuspal deflection during provisionalization. A resin composite buildup can also serve as a core for the cast restoration and prevent excessive loss of sound tissue.

In accordance with previous studies, most cracks were found in molars.[7,20] This high incidence of cracks in molars may be attributed to excursive interference or parafunction.[8] These teeth have a shorter distance to the temporomandibular joint compared to premolars, which may result in higher forces applied during clenching. Clinical studies reinforce anecdotal evidence that parafunctional activity of the patient combined with interferences and a violated tooth structure create an unstable situation.[8,20] Articulated diagnostic and master casts were mounted in a semiadjustable articulator with a facebow transfer and centric relation record for every patient in the study. Wear facets and interferences in lateral, lateroprotusive, and protrusive excursions were recorded in many teeth. It was mandatory for all patients to equilibrate the occlusion to avoid occlusal interferences during excursive movements.

During the evaluation period, 3 failures were recorded. Failures occurred no later than after 5 months. It is of interest that no failures were recorded after this period. These findings cannot be compared with other longitudinal studies in the literature; however, endodontic treatments were also reported as a final treatment by other authors.[18,20] Concerning the reasons for failure, 1 SEM investigation found that all symptomatic cracks in teeth appear to be extensively contaminated by bacteria.[16] Bacterial contamination of cracks in symptomatic vital teeth may represent a cause of pulpitis after the treatment of cracked teeth.

Surgical loupes or surgical microscopes may help the clinician to detect the crack, distinguish the orientation, and provide fine detail; however, it is not possible in vivo to estimate how deep the crack extends through the dentin. It is also of clinical interest that bioincompatibility is still considered a potential problem associated with the use of all dentin adhesives.[25,26] An additional factor that may have contributed to pulpitis is the direct diffusion into the pulp of components of the 3-step dentin adhesive used in this longitudinal study. Although this hypothesis has not been determined or confirmed in the literature, it should be further investigated. On the other hand, it is interesting to note that painful, cracked teeth can be treated with an interim resin composite restoration (used as a buildup) placed with the Total Etch adhesive system before cavity preparation. This evidence was confirmed by previous clinical studies.[20–22]

The present study has some limitations: all clinical procedures were performed by 2 clinicians, and the onlays were placed over a period of 6 years, not simultaneously. Nevertheless, this study also offers some major advantages compared to previously published investigations, such as the large sample size and longer follow-up periods, as well as the fact that all patients were serially accounted for at the end of the study. All data were accurately analyzed and presented so that they could be compared with other studies.

Conclusions

Despite the limitations of this retrospective clinical investigation, the results show that bonded indirect resin composite onlays can be successful in treating painful, cracked teeth. Furthermore, it appears that cuspal protection should be incorporated into the design of coronal restorations. However, further studies are required to confirm these encouraging results.

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Literature Abstract

A meta-analysis of clinical studies to estimate the 4.5-year survival rate of implants placed with the osteotome technique

This paper aimed to systematically review the data from reported clinical studies regarding the osteotome technique, with the purpose of estimating the overall survival rate of implants by means of a meta-analysis. The literature was searched using Medline for studies published from 1953 to 2005. Inclusion criteria were: *(1)* clinical studies or clinical reports investigating the osteotome technique for dental implantation, and *(2)* control or test group(s) from clinical studies or clinical reports, even if they did not fit with other criteria. By pooling the data of the included studies, overall Kaplan-Meier survival curves were constructed for the periods before and after loading. The initial literature search yielded 164 studies, but after the selection procedure, only 5 studies remained for the meta-analysis. The combined data of 349 implants revealed survival probabilities of 98% (CI: 97.2% to 100%) until loading and 99% (CI: 94% to 100%) after 56 months of loading. At the end of the observation period, 41 implants in 18 patients were still at risk. The authors thus concluded that for the period investigated, the prognosis of implants placed using the osteotome technique seems to be similar to published data of implants placed by conventional drilling techniques. However, considering the study's limitations, ie, that all except one of the studies were retrospective, the small number of implants included, and the lack of well-defined data reporting, randomized controlled clinical trials are still needed to support or refute the osteotome technique.

Shalabi MM, Manders P, Mulder J, Jansen JA, Creugers NH. *Int J Oral Maxillofac Implants* 2007;22:110–116. **References:** 45. **Reprints:** Dr John Jansen, Department of Periodontology and Biomaterials, Dentistry 309, Radboud University Nijmegen Medical Center, PO Box 9101, 6500 HB Nijmegen, The Netherlands. E-mail: j.jansen@dent.umcn.nl—*Tapan N. Koticha, National University of Singapore Faculty of Dentistry, Singapore*