Single Tooth Replacement by Morse Taper Connection Implants: A Retrospective Study of 80 Implants

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The goal of this study was to provide data relative to the use of a new implant system (Mac System, Cabon, Milan, Italy) with a Morse taper implant-abutment connection for single implant restorations. The implant system is composed of an endosseous screw made of commercially pure titanium grade 2, while the abutment is titanium alloy (Ti-6Al-4V). A total of 80 single implants were placed in 69 patients (36 women and 33 men, mean age 42 years, range 16 to 61). All patients gave their informed consent and received a thorough clinical and radiographic examination. Smokers and diabetics were excluded from the study. Three implants were placed in areas of previous tooth impaction, 5 were placed in posttraumatic edentulous areas, 2 were used in situations involving tooth agenesis, and 60 replaced teeth lost because of caries or periodontal disease. All patients were edentulous for at least 1 year prior to treatment. The implants received a definitive prosthesis and had been in function for a mean period of 3.5 years. At second-stage surgery, 2 implants were removed because of lack of osseointegration. After 2 years of loading, 1 implant showed evidence of peri-implantitis and was removed. In addition, 2 fractured abutments and 1 loosened abutment were observed. Few mechanical or infectious complications were seen, and this may have been the result of high stability of the conical connection. (INT J ORAL MAXILLOFAC IMPLANTS 2001;16:675–680)

Key words: *biomechanics, dental abutments, dental implants, single-tooth implants*

The use of dental implants in the treatment of edentulous patients has become a routine clinical procedure because of the high success rates obtainable.[1,2] Epidemiologic studies have indicated that single tooth loss affects all age groups.[3] The necessity for replacing a missing tooth, especially in the anterior area of the mouth, is mainly the result of esthetic considerations. In the past decade, more and more single teeth have been replaced with dental implants, with the rationale for treatment based on data from longitudinal studies of multiple osseointegrated implants. Preliminary results of a multicenter retrospective study[4] involving 174 single-tooth ITI implant restorations suggested favorable survival rates (97.7% success). In this study survival rates were reported for anterior, premolar, and also for molar areas.

In another study[5] with an original 174 implants, 157 were examined after 2 or more years. Twenty-two single-tooth implants remained in the anterior and 135 implants (86%) remained in the posterior area of the mouth, with 81 restored with an octabutment screw-retained crown and 76 restored with a conical abutment cemented crown. Occlusal screw loosening was observed in 22.2% of the implants, with only 1 restoration loosening in both study periods (6 months to 2 years and ≥ 2 years). Loosening of a solid conical abutment occurred in one additional patient, for a cumulative conical abutment loosening of 5.3%. Three implants fractured, all mandibular first molars with hollow-screw or hollow-cylinder implant design. The survival rate at ≥ 2 years was 95.5%.

In a clinical follow-up study carried out on 69 patients,[6] 80 single-tooth implant restorations were provided. The patients were followed for 3 years and only 1 implant was lost. Thus, the cumulative success rate (CSR) was 98.7% for the follow-up

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Fig 1a Mac System implant showing the Morse taper connection.

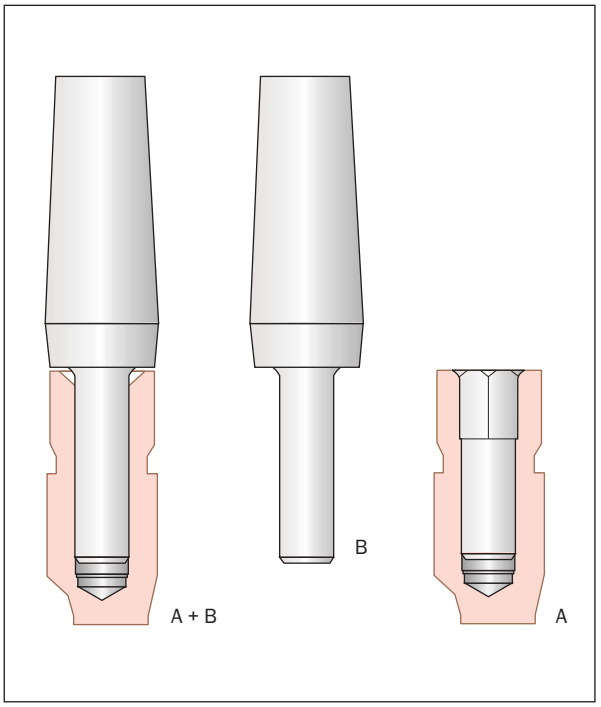

Fig 1b *(Right)* Diagrammatic representation of the system.

period. The most frequent prosthetic complication was loosening of the abutment screw, found in 10 crowns (28%). Two prospective clinical studies[7,8] found few complications with Astra Tech single-tooth implants. Both studies had a 2-year follow-up period and concluded that a conical implant-abutment interface prevented mechanical problems. Survival rates were reported to be 100%.

A comparative study[9] using 1 or 2 Brånemark System implants to replace a single molar was conducted. Forty-seven individuals comprised 2 groups of 22 patients with 1 implant each and 25 patients with 2 implants each, for a total of 72 implants placed. After the third year follow-up, the cumulative success rate was 99%. Prosthesis mobility or screw loosening was the most frequent complication and was predominant in the subjects with 1 implant (48%), while complications were reduced in the subjects using 2 implants (8%).

Longitudinal studies of single tooth replacements[10–15] have reported a success rate of 97% if reference is made to the implant survival rate at 5 years; however, if reference is made to the implant-abutment connection, the rate of failure was high (from 25% to 43%).[13,16–18] The purpose of this study was to provide longitudinal data relative to the use of a new implant system (Mac System, Cabon, Milan, Italy) with a Morse taper connection for single-tooth implant restorations.

MATERIALS AND METHODS

Implants

The implants used in this study were manufactured from cold-worked, grade 2 commercially pure titanium, exhibiting a screw design and an outer diameter of 3.75 mm or 4.25 mm (Fig 1a). The most coronal 2 mm portion of the implant is smooth and contains an internal hexagon. The screw portion is acid-etched, and the implants are then γ-ray sterilized. The implants present a cylindric, hollow cavity that becomes conical in the apical portion. The abutment is inserted in this cavity, and because of the different grade of the taper connection, becomes locked if pressure of 200 to 250 N is applied (Fig 1b). The abutment is made of titanium alloy (Ti-6Al-4V).

A recent study[19] has shown that the Morse taper connection is stable under a vertical pressure of 800 N, corresponding to the most unfavorable load possible during mastication. During that experiment, no variation in the connection was seen (Fig 2). For other implants under the same conditions, loosening or fracture of the screws has been reported.[20,21] Different angulations (10, 20, or 30 degrees) for the abutments are available.

Patients and Site Selection

A total of 80 implants were placed in 69 patients (36 women and 33 men, mean age 42, range 16 to 61).

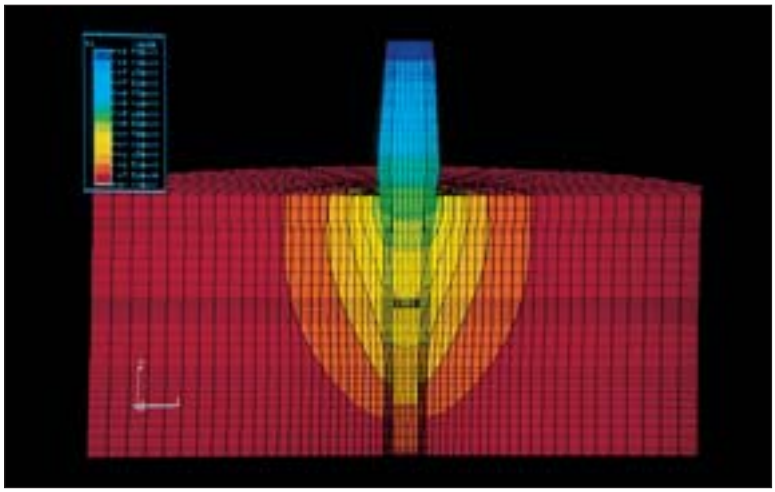

Fig 2 Axial movement of the Morse taper connection under 400 N load (computerized analysis). Reprinted from Pietrabissa et al[19] with permission of Dentista Moderno UTET Italy.

All patients gave their informed consent and received a thorough clinical and radiographic examination. Smokers and diabetics were excluded from the study. All teeth had been extracted at least 1 year prior to implant placement (Tables 1 and 2).

Surgical Technique

All implants were placed by the same operator. Immediately prior to surgery, patients were asked to rinse with chlorhexidine digluconate 0.2% for 2 minutes. An incision was made slightly palatal to the alveolar crest, and full-thickness flaps were elevated to expose the alveolar bone. Preparation of the threaded implant sites was undertaken using surgical guides and according to the standard clinical procedures for the Mac Implant System. Implants were placed in the bone, and care was taken not to expose any of the threads, leaving only 1 mm of the smooth collar of the implants above the bone crest. If adequate stability was not achieved, the implant was removed. Flaps were sutured with e-PTFE sutures (Gore-Tex, Flagstaff, AZ). Antibiotics (amoxicillin 1 g 2 times/day) were prescribed for 10 days and analgesics as required. Sutures were removed 2 weeks after surgery. Second-stage surgery was performed after an average healing period of 3 to 4 months in the mandible and 6 to 7 months in the maxilla. At this time stability of the implants was verified and healing abutments were connected to the implants.

Table 1 No. and Dates of Implant Placement

Date placed	No. placed
1992	2
1993	7
1994	17
1995	13
1996	12
1997	12
1998	5
1999	12

Table 2 Locations of Implants Placed

Arch	Central incisor	Lateral incisor	Canine	Premolar	Molar
Maxilla	5	12	4	20	3
Mandible	1	1	0	9	25

In all cases, standardized radiographs were taken immediately after implant placement and at second-stage surgery.

Restorative Procedure

All implants were restored with ceramic crowns 1 month after stage 2 surgery was performed. The

Fig 3a Patient (18-year-old female) with lateral incisors (agenesis) replaced using Mac System implants.

Figs 3b and 3c The same patient after 5 years.

Table 3 Implant Failures

Causes of failure	No. of implants
Lack of osseointegration	2
Peri-implantitis	1
Abutment fractures	2
Abutment disactivation	1

crowns were cemented to the abutment with a temporary cement, maintaining the most apical part of the crowns either gingivally or 1 to 2 mm beneath the gingival margin.

RESULTS

At stage 2 surgery, 1 implant in each of 2 patients was not osseointegrated and was removed. After 2 years of loading, 1 implant showed bleeding on probing, the presence of a 5-mm pocket, and bone resorption. The diagnosis made was peri-implantitis. Therapy consisted of mechanical debridement associated with chemical (citric acid pH 1) and antibiotic topical therapy (metronidazole gel). In addition, systemic therapy was administered (amoxicillin and clavulanic acid for 10 days). The peri-implantitis resolved, the implant was stable, and no other complications occurred during the follow-up period (4 years).

All implants were restored with single crowns and functioned for a mean time of 3.5 years (Figs 3a to 3c). The complications involved 2 fractures and 1 loosening of the abutment. In all 3 patients, the implants were located in the mandible; the 2 fractures were in molar positions and the loosening was in the premolar position. In all cases, new abutments were placed and the implants were returned to function (Table 3).

DISCUSSION

In previous studies, the most frequently reported cause of failure for single-tooth replacements with implants has been the loosening or fracture of the screws.[22] Wie[16] reported 25% loosening or fracture of screws in 56 patients. In a retrospective study, Ekfeldt and associates[13] evaluated single-tooth restorations supported by osseointegrated implants and found that the most frequent failures (43%) were related to the screws. Cordioli and coworkers[12] and Binon and coworkers[17,18] also reported mechanical failure related to the abutment-implant connection. The aggregate data suggest that single-tooth implant replacement is predictable therapy, but the implant-abutment connection can be subject to failure.

Structural computerized analysis of a geometric 3-dimensional model of mandibular bone involving the study of a implant with a Morse taper connection loaded with 800 N forces revealed an absolutely stable system, with no alteration of the contact between the implant and the abutment.[19] In the present study, only 3 mechanical failures (1 screw loosening and 2 fractures of the abutment) were observed.

The crevicular sulcus around implants should not be deeper than 3 mm to control subgingival bacterial plaque and maintain sulcular health.[23] The implant employed here has a smooth collar of 2 mm, which enhances formation of the surrounding attachment apparatus.[24] In all implants with an external hexagon, the implant-abutment connection is located near the alveolar crest, and it has been demonstrated that this area can be colonized by bacteria migrating from the inner aspect of the implant.[25,26] In the Mac System implant, the connection is located near the free gingival margin in a position very accessible to normal hygienic procedures. A recent study has

shown that the Morse taper connection provides a barrier against fluid penetration.[27]

Prosthetic crowns that are cemented to abutments have been reported to result in a higher standard of function and esthetics.[28] In the present study, all crowns were cemented with temporary cement and were designed with margins that were supragingival or level with the peri-implant gingiva. Complications reported in the literature have been related mainly to screw-type implants,[12,13,16–18] and the failures were primarily fractures and screw loosening (25% to 43%). In this study, only 3 failures (3.75%) of a total of 80 implants in service during a mean period of 3.5 years observation time were seen.

The implant failure rate is higher in posterior areas in comparison with the anterior areas of the mouth[29] because of local anatomic and mechanical conditions. It is noted that the periodontal surface of a molar tooth varies from 450 to 533 mm^2, while the surface of a 3.75-mm implant is 72 to 256 mm^2 in relation to its length. In these situations, it has been proposed that wider-diameter implants be used[30–32] or that two 3.75-mm implants be used[9,13,33] to replace 1 molar to help the restoration withstand occlusal forces.[31] When 2 implants are positioned for a single molar replacement, the minimum interimplant space required is 1.5 mm, while the total interdental space required should be at least 12 to 13 mm.[34] In the present study, 28 implants were placed in molar positions and only 2 abutments (7.14%) resulted in fracture after 1 year loading. These data are favorable in comparison to the Becker and Becker study,[35] which revealed a 38% incidence of loosening in 21 molar implants (average 24 months of loading).

In a retrospective study,[36] the clinical response to the use of single implants with a progressive thread design (Ankylos, Degussa-Hüls AG, Hanau, Germany) in the replacement of molar teeth was evaluated. Fifty-eight implants (10 in the maxilla and 48 in the mandible) were placed in 51 patients. The implants were in function for 20.6 months. All crowns were cemented to the abutments. Two implants were lost (fracture) and the survival rate was 96.55%. In the Ankylos implant system, the connection between the implant and the abutment is conical, and this interface appears to avoid biomechanical and biologic complications because there is no microgap. An in vitro comparison of accepted maximum bending moments before fracture, deformation, or abutment loosening between a conical abutment interface (Astra Tech implants, Lexington, MA) and a butt joint interface (Brånemark System implants, Nobel Biocare, Yorba Linda, CA) was performed and demonstrated that the conical abutment design had a higher resistance to loading forces than the butt joint interface.[37] Previous studies by Jemt and colleagues[22] and Laney and coworkers[38] indicated that screw joints may cause problems. Regarding the problem of screw loosening, these authors showed that restorations in the premolar region had a higher rate of loose screws during the first year of function (26%) than restorations in the anterior region. In different clinical investigations, failures of 3.75-mm-diameter Brånemark System implants related to fracture of the implant or abutment screw accounted for 14% of the examined implants replacing single molars.[32]

SUMMARY

The present retrospective investigation has pointed out that the Morse taper connection can provide a very low incidence of failures that can be prevented if in the molar regions of the mouth, wider implants or 2 implants are placed. Within the limits of this study, it is possible to conclude that the implant system reported here is durable for single-tooth replacements.

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