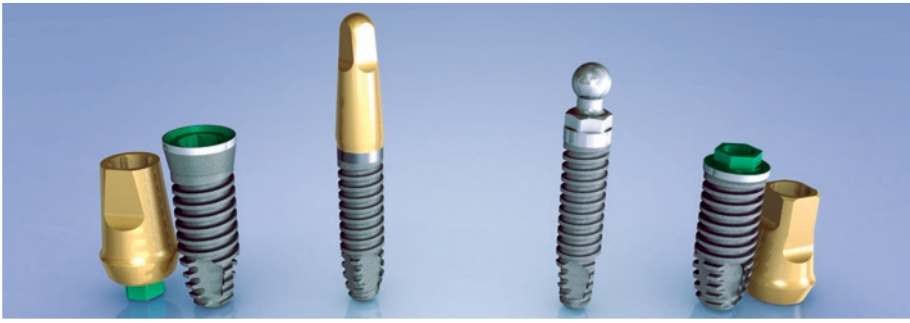


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Short Dental Implants

Short Dental Implants in Posterior Partial Edentulism: A Multicenter Retrospective 6-Year Case Series Study

Carl E. Misch, Jennifer Steigenga, Eliane Barboza, Francine Misch-Dietsh, Louis J. Cianciola, and Christopher Kazor

Background: Implants <10 mm long in the posterior regions of partially edentulous patients have a higher failure rate in many clinical reports. The purpose of this case series study was to evaluate implant survival when a biomechanical approach was used to decrease stress to the bone-implant interface.

Methods: A retrospective evaluation of 273 consecutive posterior partially edentulous patients treated with 745 implants, 7 or 9 mm long, supporting 338 restorations over a 1- to 5-year period was reviewed from four private offices. Implant survival data were collected relative to stage I to stage II healing, stage II to prosthesis delivery, and prosthesis delivery to as long as 6 years follow-up. A biomechanical approach to decrease stress to the posterior implants included splinting implants together with no cantilever load, restoring the patient with a mutually protected or canine guidance occlusion, and selecting an implant designed to increase bone-implant contact surface area.

Results: Of the 745 implants inserted, there were six surgical failures from stage I to stage II healing. All five failures were with a one-stage surgical approach (240 implants). There were two failures from stage II healing to prosthesis delivery. No implants failed after the 338 final implant prostheses were delivered. A 98.9% survival rate was obtained from stage I surgery to prosthetic follow-up.

Conclusions: Short-length implants may predictably be used to support fixed restorations in the posterior partial edentulism. Methods to decrease biomechanical stress to the bone-implant interface appear appropriate for this treatment. *J Periodontol 2006; 77:1340-1347*

Single-tooth Immediate Non-functional Load

Five-year Outcome of 111 Immediate Nonfunctional Single Restorations

Marco Degidi, Adriano Piattelli, Peter Gehrke, Pietro Felice and Francesco Carinci

Immediate loading is a surgical-prosthetic procedure extensively used in implant dentistry. Despite its frequent use, minimal data are available on the long-term clinical success rate of immediate functional loading (IFL) and immediate nonfunctional loading (INFL) of implants. The aim of this study was to evaluate the long-term survival and bone loss of immediate nonfunctional single implant restorations in a group of patients that were monitored for 5 years.

One hundred and eleven patients (41.4% men) with a median age of 40 years were included in this study. A total of 111 implants were placed. All implants were placed with a minimum insertion torque of 25 Ncm. A temporary restoration was relined with acrylic resin, trimmed, polished, and cemented or screw retained 1 to 2 hours later. Occlusal contact was avoided in centric and lateral excursions. After provisional crown delivery, a periapical radiograph was performed by means of a customized Rinn holder device. Data were analyzed by means of Kaplan-Meier and life-table algorithms. Stratification of implant survival was performed for the available variables of interest, and comparisons were analyzed using a log-rank test.

Investigated parameters were time of implant placement, bone quality, implant site, implant diameter and length, and type of implant surface enhancement. The parameters for overall success rate were defined by bone resorption >1.5 mm after the first year of loading and >0.2 mm thereafter. During the 5-year follow-up period, a survival rate of 95.5% was observed. All failures occurred within 4 months of implant loading. There were statistically significant differences regarding healed vs. post-extraction implant sites (100% and 92.5%, respectively, $P = .05$) and type of bone (D1 vs. D4 yielded 100% and 95.5%, respectively, $P < .05$). No differences were detected for: (1) site (100% for mandible and 94.6% for maxilla, $P = .319$); (2) implant diameter (survival rates of 97.26% for <4.5-mm diameter and 92.11% for >4.5- mm diameter, $P = .206$); (3) implant lengths (survival rates of 96.97% for implants >13 mm and 94.87% for implants <13 mm, $P = .624$); and (4) type of implant surface enhancement (survival rates of 94.03% for 67 cases of grit-blasted and acid-etched surfaces and a failure rate of 4 out of 5, and 94.12% for 17 cases of hydroxyapatite (HA)-coated surfaces with only 1 failure).

The success rate (defined as bone resorption >1.5 mm after the first year of loading and >0.2 mm thereafter) was 97.2%. Immediate nonocclusal loading of single implants is a reliable surgical-prosthetic procedure with a low rate of implant loss and a low quantity of peri-implant bone loss over time. *J Oral Implantol 2006;32:43-51*

3mm Diameter One-piece Implants

Initial Clinical Efficacy of Immediate Function 3mm Implants in Limited Spacing Areas.

Michael Reddy, Jean O'Neal, Sandra Haigh, Ruth Aponte-Wesson, and Nico Geurs

Purpose: The objective of this study was to determine changes in interdental papillae, alveolar bone loss, esthetics, and initial healing success when one-piece narrow diameter implants are immediately loaded in limited tooth-to-tooth spacing sites.

Materials and Methods: 31 implants were placed in 17 subjects. Digital photographs were made at each clinical visit to assess soft tissue healing. Interproximal soft tissue fill of the embrasure was assessed with a modified Jemt index. Standardized radiographs were made at baseline (implant placement) and at interim healing (6 and 12 months post-surgery). Radiographic bone height was measured from a consistent landmark on the implant. A one-sided t-test was used to determine statistical differences of bone height.

Results: One implant had clinical mobility and was removed for an overall survival rate of 96.7%. Mean bone height on the day of placement and restoration was 2.33 ± 0.73 mm above the first thread. Mean bone height at 6 and 12 months post restoration was 1.75 ± 0.78 ; 1.63 ± 0.81 mm respectively. There was a statistically significant loss of bone support over the initial six months (0.58mm; $p < 0.01$) with no significant progression thereafter (0.12mm; NS). Complete fill of the papillae was found in 92% of maxillary lateral sites and 60% of mandibular incisor sites.

Discussion and Conclusion: The use of narrow diameter one-piece immediately loaded implants appears to be an effective prosthetic treatment for areas of limited spacing. *Submitted for publication: Int J Oral and Maxillofac Implants 2006*

Prosthetic Technique - Immediate Load Splinting

Syncrystallization: A Technique for Temporization of Immediately Loaded Implants with Metal-Reinforced Acrylic Resin Restorations

Marco Degidi, Peter Gehrke, Andre Spanel and Adriano Piattelli

Background: Rigid temporization has been recognized to have a significant impact on the peri-implant tissue response in immediate implant loading since it reduces the mechanical stress exerted on each implant.

Purpose: A successful protocol for immediate loading of multiple implants depends on an adequate fixation and immobility of the implants to prevent the risk of micromovements in relation to the surrounding bone. The objective of this article was to evaluate a prosthetic concept for an accelerated rigid splinting of multiple implants for same-day immediate loading with metal-reinforced provisional restorations using a technique of welding temporary implant abutments with a prefabricated titanium bar directly in the oral cavity (syncrystallization).

Materials and Methods: Between June 2004 and January 2005, immediate loading of threaded implants with a metal-reinforced acrylic resin provisional restoration at stage 1 surgery was evaluated in 40 consecutive patients. A total of 192 implants were placed in selected edentulous or partially edentulous patients using the syncrystallization technique. Once the titanium bar was welded intraorally to the abutments, opaque was applied and the provisional restoration was relined and screw-retained the same day. In addition, a comparison of deformations and stress distributions in implant-supported, metal-reinforced and nonmetal-reinforced resin provisional restorations was analyzed in the edentulous mandible by a three-dimensional finite element model (FEM).

Results: All of the 192 rigidly temporized immediately loaded implants osseointegrated. An implant success rate of 100% was achieved over a period of 6 months postplacement. No fracture or luting cement failure of the provisional restoration occurred during the observation time. Compared to mere acrylic superstructures, a significant reduction of deformation and strain within metal-reinforced provisional restorations was detected by FEM analysis.

Conclusion: The results of this study indicate that the syncrystallization technique allows an expedite and adequate rigid splinting of multiple immediately loaded implants. The advantages of the technique are: (1) reduction of treatment time for immediate temporization at stage 1 surgery; (2) predictable fixation and immobility of implants in the early stages of bone healing; and (3) less time for repairing provisional restorations as a result of no or rare fracture. *Clin Implant Dent Relat Res 2006;8:123-134*

Immediate Load - Human Histology

Histologic and Histomorphometric Findings From Retrieved, Immediately Occlusally Loaded Implants in Humans.

George E. Romanos, Tiziano Testori, Marco Degidi, and Adriano Piattelli

Background: The immediate loading treatment concept can be successfully used in implant dentistry. Bone cells migrate onto the implant surface and establish a stable anchorage on the titanium surface. When implants are loaded immediately after surgery, there is a high long-term success rate of the implant-supported reconstruction. Based on histologic observations from different animal studies, the interface of immediately loaded implants can have a direct bone-to-implant connection without any fibrous tissue formation. Mature bone formation is dependent on the loading period. The aim of this study was to demonstrate a histologic analysis of retrieved, clinically stable immediately loaded implants with different implant designs and surfaces. An objective demonstration of the bone-implant interface was presented for the implant systems used.

Methods: A total of 29 implants [N. BioHorizons = 6] with different implant designs and surfaces were retrieved from patients who were treated with implants using an immediate loading protocol and fixed immediate restorations placed the same day after surgery. The loading period was between 2 and 10 months. The bone-implant interface was examined histologically and histomorphometrically.

Results: A high bone-to-implant percentage of 66.8% ($\pm 8.9\%$) [BioHorizons BIC% = 80.6%] was found in the examined retrieved implants. Some marginal bone resorption was observed in the crestal part of the implants.

Conclusion: According to the present histologic and histomorphometric evaluation of retrieved, clinically stable implants, immediate occlusal loading can present a high level of bone-to-implant contact in humans. *J Periodontol* 2005; 76:1823-1832

Modified Square-thread Geometry

Effects of Implant Thread Geometry on Percentage of Osseointegration and Resistance to Reverse Torque in the Tibia of Rabbits.

Jennifer Steigenga, Khalaf Al-Shammari, Carl Misch, Francisco H. Nociti Jr., and Hom-Lay Wang

Background: Dental implant thread geometry has been proposed as a potential factor affecting implant stability and the percentage of osseointegration. Therefore, the aim of this prospective, randomized, parallel arm study was to evaluate the effects of dental implant thread design on the quality and percent of osseointegration and resistance to reverse torque in the tibia of rabbits.

Methods: Seventy-two custom-made, screw-shaped, commercially pure titanium implants (3.25 mm diameter \times 7 mm length) were placed in the tibiae of 12 white New Zealand rabbits. Each tibia received three implants of varying thread shapes: one with a V-shaped, one with a reverse buttress, and one with a square thread design. The rabbits were sacrificed following an uneventful healing period of 12 weeks. Implants in the right tibiae underwent histologic and histomorphometric assessments of the bone-to-implant contact (BIC) and the radiographic density of surrounding bone, while implants in the left tibiae were used for reverse-torque testing. Differences between the three thread designs were examined using analysis of variance (ANOVA).

Results: Data showed that the square thread design implants had significantly more BIC and greater reverse-torque measurements compared to the V-shaped and reverse buttress thread designs, while no differences were found in radiographic bone density assessments.

Conclusion: These results indicate that the square thread design may be more effective for use in endosseous dental implant systems. *J Periodontol* 2004;75:1233-1241

Immediate Loading

Immediate Functional and Non-Functional Loading of Dental Implants: A 2- to 60-Month Follow-Up Study of 646 Titanium Implants.

Degidi M & Piattelli A

Background: The aim of this study was the evaluation, from a clinical point of view, of implants subjected to immediate functional loading (IFL) and to immediate non-functional loading (INFL) in various anatomical configurations.

Methods: The study included 152 patients who had given their informed consent. A total of 646 implants [N. BioHorizons = 242] were inserted. The implants were placed in 39 totally edentulous mandibles, 14 edentulous maxillae, 23 edentulous posterior mandibles, 16 edentulous anterior mandibles, 16 edentulous anterior maxillae, and 15 edentulous posterior maxillae. Fifty-eight implants were used to replace single missing teeth. In 65 cases, IFL was carried out for 422 implants. INFL was carried out in 116 cases, (224 implants).

Results: In the IFL group 6 of 422 implants failed (1.4%) [N. BioHorizons = 0/0%]; in the INFL group 2 of 224 implants failed (0.9%) [N. BioHorizons = 0/0%]. All the other implants appeared, from clinical and radiographic observations, to have successfully osseointegrated and have been functioning satisfactorily since insertion. All failures were observed in the first few months after implant loading.

Conclusion: Immediate functional and non-functional loading seems to be a technique that gives satisfactory results in selected cases. *J Periodontol* 2003;74:225-241

Immediate Loading

Five-Year Prospective Study of Immediate/Early Loading of Fixed Protheses in Completely Edentulous Jaws with a Bone Quality-Based Implant System.

Misch CE & Degidi M

Background: The concept of immediate loading of root-form implants for fixed restorations has received increasing interest over the last 5 years. Several authors have commented on parameters that may influence results, including implant number; implant length, bone density, and patient habits. The trigger for bone remodeling around an implant may occur from the surgical trauma of insertion or the mechanical environment of strain at the interface. In the classic two-stage approach, these were divided episodes, separated by 3 to 6 months. Immediate loading compresses this time frame; the two driving mechanisms for bone repair occur concurrently. A scientific approach to the interface development is to match the bone healing response of trauma (woven bone of repair) to the response of mechanical load (reactive woven bone), so the sum of these two entities does not result in fibrous tissue formation and clinical mobility of the implant.

Purpose: It is the purpose of this article to review the scientific rationale of these statements and coordinate them to bone physiology and bone biomechanics.

Materials and Methods: Findings from previous reports in the literature were reviewed and summarized to form the basis of a prospective study using a bone quality-based implant system (Maestro, BioHorizons Implant Systems, Inc., Birmingham, AL, USA). A transitional prosthesis was delivered either on the day of surgery or within 2 weeks for 30 patients and 31 arches. A total of 244 implants were used to support these restorations, for an average of 7.8 implants per prosthesis. After 4 to 7 months, the final restorations were fabricated. One year after the final restoration was loaded, the implant survival was 100%; the 31 restorations also had a survival of 100% over this time frame. This report presents these implants and restorations over a 1- to 5-year period, with an average follow-up period of 2.6 years.

Results: The bone loss from implant insertion to final prosthesis delivery averaged 0.7 mm. The first-year bone loss after final prosthesis delivery averaged 0.07 mm. A slight increase in bone height was observed after the first year, but generally no increase was observed over the remaining evaluation period.

Conclusions: In the current report, no implant failure occurred, and crestal bone loss values were similar to or less than values reported with the conditional two-stage approach. This may be related to the number and position of implants, implant design, and/or the surface condition of the implant loading. *Clin Implant Dent Relat Res* 2003;5:17-28

99.5% Success in All Bone Densities

A Prospective Multi-Center Clinical Investigation of a Bone Quality-Based Dental Implant System.

Kline R, Hoar JE, Beck GH, Hazen R, Resnik RR and Crawford EA

This article reports the five-year results of an independently monitored, prospective, multi-center, clinical trial of a bone quality-based implant design. At six study centers, 495 implants were placed in 151 cases with an average follow-up period of 1.6 years (range 1.0 to 3.6 years), following prosthesis delivery. The majority of the implants placed were D2 or D3 implants to support fixed partial dentures or implant-supported overdentures. Using strict success criteria, there were three implant failures, resulting in a cumulative 99.5% success rate according to Kaplan-Meier survival analysis. Radiographic analysis revealed a mean bone loss of 0.06 mm at one year and bone gain of 0.04 mm at two years following prosthesis loading. There were no statistical differences in the results by center, implant type, bone density, area of the mouth, or prosthesis type. The results of this five-year study revealed a high success rate and limited bone loss in all areas of the mouth, independent of bone quality. *Implant Dent* 2002;11:224-234

Resorbable Blast Texturing Surface - RBT

Bone Response to Machined and Resorbable Blast Material Titanium Implants: An Experimental Study in Rabbits.

Piattelli M, Scarano A, Paolantonio M, Iszzi G, Petrone G & Piattelli A

The aim of the present study was a comparison of bone's response to a machined surface and to a surface sandblasted with hydroxylapatite (HA) particles and resorbable blast material (RBT)). Threaded machined and RBT, grade 3, commercially pure, titanium, screw-shaped implants were used in this study. Twenty-four New Zealand white mature male rabbits were used. The implants were inserted into the articular femoral knee joint according to a previously described technique. Each rabbit received 2 implants, 1 test (RBT) and 1 control (machined). A total of 48 implants (24 control and 24 test) were inserted. The rabbits were anesthetized with intramuscular injections of fluanisone (0.7 mg/kg body weight) and diazepam (1.5mg/kg b.wt.), and local anesthesia was given using 1 ml of 2% lidocaine/adrenalin solution. Two rabbits died in the postoperative course. Four animals were euthanatized with an overdose of intravenous pentobarbital after 1,2,3, and 4 weeks; 6 rabbits were euthanatized after 8 weeks. A total of 44 implants were retrieved. The specimens were processed with the Precise 1 Automated System to obtain thin ground sections. A total of 3 slides were obtained for each implant. The slides were stained with acid and basic fuchsin and toluidine blue. The slides were observed in normal transmitted light under a Leitz Laborlux microscope, and histomorphometric analysis was performed. With the machined implants, it was possible to observe the presence of bone trabeculae near the implant surface at low magnification. At higher magnification many actively secreting alkaline phosphatase positive (ALP+) osteoblasts were observed. In many areas, a not yet mineralized matrix was present. After 4 to 8 weeks, mature bone appeared in direct contact with the implant surface, but in many areas a not yet mineralized osteoid matrix was interposed between the mineralized bone and implant surface. In the RBT implants, many ALP+ osteoblasts were present and in direct contact with the implant surface. In other areas of the implant perimeter it was possible to observe the formation of an osteoid matrix directly on the implant surface. It must be stressed that these results have been obtained in a passive, nonloaded situation. *J Oral Implantol 2002;28:2-8*

Resorbable Blast Texturing Surface - RBT

Histomorphometric Analysis of the Bone-Implant Contact Obtained with 4 Different Implant Surface Treatments Placed Side by Side in the Dog Mandible.

Novaes AB, Souza SLS, de Oliveria PT & Souza AMMS

Purpose: The different implant systems available today present several types of surface treatments, with the aim of optimizing bone-implant contact. This study compared 4 different types of implant surfaces.

Materials and Methods: The first, second, third, and fourth mandibular premolars were extracted from five young, adult mongrel male dogs. Ninety days after removal, four 3.75-mm-diameter, 10-mm-long screw-type implants (Paragon) were placed with different surface treatments in mandibular hemiarches. The dogs received two implants of each of the following surface treatments: smooth (machined), titanium plasma spray (TPS), hydroxylapatite coating (HA) and sandblasting with soluble particles (SBM). The implants were maintained unloaded for ninety days. After this period, the animals were sacrificed, and the hemimandibles were extracted and histologically processed to obtain non-decalcified sections. Two longitudinal ground sections were made for each implant and analyzed under light microscopy, coupled to a computerized system for histomorphometry.

Results: The following means were obtained for bone-implant contact percentage: machined = 41.7%, TPS = 48.9%, HA = 57.9%, and SBM = 68.5%.

Discussion: The means for all treatments that added roughness to the implant surface were numerically superior to the mean found for the machined surface. However, this difference was statistically significant only between groups SBM and machined (Tukey test, $P < .05$).

Conclusions: The SBM-treated surface provided a greater bone-implant contact than a machined surface after 90 days without loading in this model. *Int J Oral and Maxillofac Implants 2002;17:377-383*

Note: SBM (Sandblasted with Soluble Particles Medium) is equivalent to RBT (Resorbable Blast Texturing) surface treatment. Both surface treatments are performed by Bio-Coat in Southfield, Michigan.

Bio-Engineering for Cellular Response

A Bioengineered Implant for a Predetermined Bone Cellular Response to Loading Forces. A Literature Review and Case Report.

Misch CE, Bidez M & Sharaway M

The presence of fibrous tissue has long been known to decrease the long-term survival of a root-form implant. Excessive loads on an osseointegrated implant may result in mobility of the supporting device, and excessive loads may also fracture an implant component or body. Although several conditions may cause crestal bone loss, one of these may be prosthetic overload. Excessive loads on the bone cause strain conditions to increase. These microstrains on the bone may affect the bone-remodeling rate in a direct relationship.

When strain conditions to the interfacial bone are in the mild overload zone, an increased bone remodeling response occurs, which results in a reactive woven bone formation that is less mineralized and weaker. Greater stresses may cause the interfacial strain to reach the pathologic overload zone and may cause microfracture of the bone, fibrous tissue formation, and/or resorption. Recent reports suggest that the bone remodeling rate next to an implant may be used to evaluate biomechanical conditions and their influences on the implant-to-bone interface. These include a number of factors, such as loading conditions, implant body surface conditions, and implant design. For a given load condition, the implant design is one of the primary factors that determine the resulting strain at the interface.

A predetermined goal was established to bioengineer a dental implant to load the bone at the interface in a predetermined stress/strain relationship, in order to maintain lamellar bone at the interface. A case report is presented of 2 bioengineered implants loaded for 1 year, which demonstrated that the bone was primarily lamellar in structure, the bone turnover rate was less than 5 microns/day, and was the same as the bone away from the interface. These findings corroborate those observed in a prior animal study reported with the same implant design. Although the number of implants evaluated in those two reports is few, they support a predetermined, histological outcome. *J Periodontol 2001;72:1276-1286*

Histology of Square-Thread Implant

Preliminary Evaluation of a New Dental Implant Design in Canine Models.

Bumgardner JD, Boring JG, Cooper RC, Cheng G, Givaruangawat S Gilbert JA, Misch CM & Steflik DE

Mathematical and in-vitro models have demonstrated that a new, square thread, dental implant design increases functional surface area and improves loading profiles in contiguous bone. The aim of this investigation was to evaluate the histological response of bone to loading in a canine model. Implants were placed in the mandibles of beagle dogs after induced posterior, partial edentulism. Three months after implantation, the animals received independent, fixed partial dentures, and were followed for an additional six months. Histological analysis revealed that each implant was osseointegrated with a mean bone contact length percentage of 53.7%. An interesting observation was the formation of more bone on the inferior aspect of the square thread and concentric lamellar bridging adjacent threads. These observations suggest a beneficial effect of the square thread geometry on bone remodeling and more rapid formation of stronger lamellar bone. *Implant Dent 2000;9:252-260*

Success in Poor Quality Bone

Endosteal Implants in the Edentulous Posterior Maxilla: Rationale and Clinical Report.

Misch CE, Poitras Y & Dietsh F

The maxillary posterior region of the mouth sustains greater bite forces compared to the anterior, yet often presents the poorest bone density. A biomechanical approach, often presented to decrease risk factors in regions of high stress or poor bone density, is to increase implant surface area. Most manufacturers provide implants in variable lengths. Sinus grafts permit longer implants; however, finite element analysis support the hypothesis that implant length is a secondary parameter for stress distribution. A more beneficial approach, to enhance implant surface area in the posterior regions, has primarily been to increase the implant diameter. However, when conventional designs and diameters are used, this only increases surface area by 30% yet bite forces increase by more than 300% in the posterior regions. A change in implant diameter and thread design (i.e. BioHorizons Implant System, Inc.) may increase surface area by more than 300%. This clinical report demonstrates an implant surgical success rate of 99.4% in the posterior maxilla, using the bone quality-based implant system from BioHorizons. In addition, there were no early loading failures and no prosthetic failures. Crestal bone loss during early loading averaged .71 mm or less, dependent upon a one-stage or two-stage surgical approach. The increase in surface area of this design, coupled with the compressive load thread of this design, may indeed be responsible for the decrease in early loading implant failure and also contribute to a decrease in crestal bone stresses, which may reduce crestal bone loss. *Oral Health 2000;8:7-15*

BioHorizons USA

One Perimeter Park South
Birmingham, AL 35243

Customer Care / Servicio al Cliente:
888-246-8338 or 205-967-7880

BioHorizons Canada

21 Amber Street, Unit # 7
Markham, Ontario L3R 4Z3

Customer Care / Service à la Clientèle:
866-468-8338 or / ou 905-944-1700

BioHorizons Ibérica

Bocángel, 38
28028 Madrid, Spain

Atención al Cliente:
+34 91 713 10 84

BioHorizons GmbH

Marktplatz 3
79199 Kirchzarten, Germany

Kunden Service:
+49 7661-909989-0

BioHorizons UK

180 Dukes Ride
Crowthorne, Berkshire RG456DS

Customer Care:
+44 (0)8700 620 550

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