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EDITORIAL
— by Torsten R. Oemus

Dear reader,

It is my pleasure to introduce the second issue of the Clinical Masters™ magazine. A great deal has happened in the last 12 months. The Clinical Masters™ Program has become a premier source of information and inspiration for dentists seeking to advance their skills and training. Over the past year, dental professionals from all over the world have attended our nine comprehensive programs and courses in esthetic and restorative dentistry, implant dentistry, endodontics, periodontics, orthodontics, prosthodontics and laser dentistry. Let me thank you for your continuing trust in our first-class training.

This magazine provides comprehensive information on the content of the programs, the facilities and the instructors. You can also read about exciting new postgraduate training and courses in beautiful locations. The Specialist for Regeneration—Dental Implantology and Periodontology Clinical Masters™ Program in Berlin, the Online Advanced Mentoring and Clinical Program in Periodontics in Campinas and the clinical course in micro-endodontics in Dubai are just three examples. As with our first issue, the magazine features relevant clinical cases that demonstrate the particular skills and expertise of our instructors in their various specialties.

The Tribune CME™ programs are known for their highly effective approach, combining face-to-face and online mentoring by established international dental professionals in some of the best higher education institutions and training centers around the world. All members can access our sophisticated e-learning platform. Furthermore, Tribune CME™ graduates and other dental professionals are entitled to join the growing Clinical Masters™ Network, a platform for specialists across to globe to share their skills and expertise.

Tribune CME™ is a brand of Dental Tribune International, the world’s leading dental publisher. We take pride in keeping dentists around the world up to date on the latest advanced technologies and techniques. Therefore, we regularly add new courses and programs to our education portfolio. Visit www.tribunecme.com to learn more and register.

I wish you stimulating reading and warmly invite you to attend our worldwide Tribune CME™ programs.

With best regards,

Torsten R. Oemus
President and CEO
Dental Tribune International
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The Nordic Institute of Dental Education (NIDE) is a joint venture of Planmeca and the University of Turku. It provides continuing education in Finland to international dental professionals seeking to reinforce their knowledge.

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Upon successful completion, participants receive a Tribune CME certificate, which is also endorsed by the educational institutions associated with Tribune CME.

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Curriculum duration: 33 hours

Authenticity number: www.TribuneCME.com/id/30/768783

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The Arthur A. Dugoni School of Dentistry is a nationally renowned institution of higher learning committed to providing world-class dental education for its students. The school is highly regarded for its innovation in its dental curriculum, including comprehensive patient care, and is a pioneer in competency-based dental education—an approach that replaces the traditional system of clinical requirements with experiences that ensure graduates possess the skills, understanding and professional values needed for the independent practice of general dentistry. The institution is committed to excellence and innovation in education, research, community service and patient care.

São Leopoldo Mandic
School of Dentistry
Campinas, Brazil

São Leopoldo Mandic is currently among the top ten institutions of higher education in Brazil. It is accredited to teach undergraduate and graduate health care programs and award master’s and doctoral degrees. It also provides continuing education courses of varying lengths, presented as live clinical procedures, workshops, practical activities, seminars, online tutorials or other variations that best support mastery of the particular subject matter. The faculty carries out outstanding scientific research, achieving impressive results and continuously aiming to improve the knowledge of its students using current methods and new technologies.

The Clinical Masters™ programs also qualify for certification from the following associated educational institutions: University of the Pacific in the U.S., São Leopoldo Mandic in Brazil, Sapienza University of Rome in Italy, who acknowledge the quality and reputation of the Tribune CME programs.
Sapienza University of Rome
Faculty of Medicine and Dentistry
Rome, Italy

Sapienza University of Rome is one of the oldest universities in the world and listed among the top-performing universities in international rankings. Sapienza offers a vast array of courses, including degree programs, doctoral courses, one- to two-year professional courses, and specialization courses in many disciplines, run by 63 departments and 11 faculties. It is in every regard a research and teaching university and carries out outstanding scientific research in most disciplines, achieving impressive results both on a national and international level.

This year, we are pleased to welcome a new partner, Université Saint-Joseph, to the group of higher education institutions offering Clinical Masters™ Programs. It will be offering the courses at its regional center in Dubai, UAE.

Université Saint-Joseph
Beirut, Lebanon
Dubai, UAE

The Faculty of Dental Medicine at Université Saint-Joseph is an institution dating back to 1920 and has a unique standing as a pioneer in the field of dentistry in the Middle East. This year, it is celebrating 96 years of existence. Around 75 percent of dentists in Lebanon have graduated from the school and its alumni are active in all Middle Eastern countries and abroad. The faculty is a dynamic and inherent part of Université Saint-Joseph, which was founded in 1875 by the Society of Jesus. It currently offers master’s and doctoral programs in various fields of dentistry, taught by experienced lecturers.

Université Saint-Joseph has a regional center in Dubai, where advanced courses in all fields of dentistry are offered in collaboration with international partners, including Dental Tribune International.
LAKE COMO INSTITUTE
— Como, Italy

Location
The Lake Como Institute is located in the town of Como, famous for its silk manufacturers. Within what remains of its twelfth-century walls is a charming historical center. The town is set on the shores of Lake Como, situated in a basin surrounded by wooded mountains and said to be the most beautiful of the Italian lakes. There is plenty to see while strolling around, including stunning villas, gardens, and sites of historical and cultural significance. www.lakecomoinstitute.com

How to get there
From Milano Malpensa Airport, located about 1 hour away by car, you can take the Malpensa Express train to Como. www.malpensaexpress.it

From Lugano Airport in Switzerland, located about 20 minutes away by car, you can take a shuttle bus to Lugano, and then a train from Lugano station to Como S. Giovanni station. www.trenitalia.it or www.sbb.ch

From Milano Linate Airport, you can take a connecting bus to Milano Centrale station and catch a train to Como S. Giovanni station (trains depart hourly).

The following transport options are available via the institute:

– a private mini-van for up to five passengers, one way from Milano Malpensa Airport to Como (at a cost of €100 + 10% VAT)
– a private mini-van for up to seven passengers, one way from Milano Malpensa Airport to Como (at a cost of €120 + 10% VAT)
– a private car (up to three passengers), one way from Milano Malpensa Airport to Como (at a cost of €80 + 10% VAT)
– There is an additional cost of €30 (one way) from Il Caravaggio International Airport (Orio al Serio International Airport).
– There is an additional cost of €10 (one way) from Milano Linate Airport.

Where to stay
All of the following hotels are located within a reasonable distance to the institute. If you would like to stay right on the lakefront, you might want to consider one of the following hotels:

Albergo Terminus dates back to the nineteenth century and has an enchanting view across Lake Como. www.albergoterminus.it | TripAdvisor Certificate of Excellence | 4-star

Palace Hotel is an historical art nouveau palace overlooking the lakefront. www.palacehotel.it | TripAdvisor Certificate of Excellence | 4-star

Hotel Metropole Suisse is located along the harbor with views of Lake Como and the Alps www.hotelmetropolesuisse.com | 4-star

Not on the lakefront, but also centrally located are the following hotels:

Albergo Del Duca, with an attractive setting on a pedestrian square, offers the hospitality of a family-run business. www.albergodelduca.it | 3-star

Avenue Hotel is located in a historical building and offers rooms with a colorful and sophisticated design. www.avenuehotel.it | TripAdvisor Certificate of Excellence | 4-star

— Lake Como Institute
The Lake Como Institute is a center dedicated to higher education in implantology. Our teaching is based on scientific and clinical research, and we adopt an interdisciplinary teamwork approach to our work. Our clinic of excellence is based on established protocols and attention to detail, two factors that we regard as important for achieving a long-lasting result. With our work philosophy of seeking to achieve the best results, combined with our 30 years of clinical experience, we offer an innovative course that will allow you to give better treatment to patients, who rely on your professionalism for their oral health.

— Prof. Tiziano Testori
received his M.D. in 1981, his D.D.S. in 1984, and his specialty qualification in orthodontics in 1986, all from the University of Milan in Italy. He is currently head of the section of implantology and oral rehabilitation at the University of Milan’s dental clinic at I.R.C.C.S. Istituto Ortopedico Galeazzi. He is also a visiting professor at the College of Dentistry at New York University in the U.S.

Dr. Testori is a fellow of the International College of Dentists and a referee for oral surgery and implant dentistry for the Italian Ministry of Health for continuing education programs. He is an active member of the European Federation of Oral Surgery Societies and an active member of and lecturer for the Academy of Osseointegration, American Academy of Periodontology, and American Association of Oral and Maxillofacial Surgeons. He is the author of over 200 scientific articles in Italian and international journals.
**Where to eat**

* I Tigli in Theoria, situated in the old palazzo and adjunct to Theoria art gallery, provides a combination of gourmet cuisine, art and history.  
  www.theoriagallery.it | 1 Michelin star

* La Colombetta is a cozy restaurant offering regional cuisine with fish dishes as its specialty.  
  www.colombetta.it

* The Market Place offers innovative and hip Italian cuisine  
  www.themarketplace.it

* L’Antica Trattoria, seasonal, traditional Italian cuisine with specialty meat dishes cooked over barbeque in view of guests  
  www.lanticatrattoria.co.it

* Tira, mola e meseda, Italian cuisine, especially dishes from Lombardy (risotto, osso bucco)  
  www.tiramolameseda.it

* Capitan Drake Enoteca, small eatery and bar, New Zealand, Italian and Mediterranean cuisine  
  www.facebook.com/Capitan-Drake-Enoteca

**What to see and do**

* Como is a very small old town and the best way to get to know it is to walk around and discover its narrow passages, old streets, quaint markets and piazzas, stopping to enjoy a cappuccino on the terrace of one of its many cafés.  

* The remarkable eleventh-century Romanesque Basilica di Sant’Abbondio has a beautiful fresco series inside the apse and a university occupies what was once the cloister.  

* Lake Como’s shores feature a varied landscape of fields, forests, imposing rocks, charming villages facing the lake and magnificent mansions with beautiful gardens, particularly from Cernobbio to Gravedona and Bellagio. The following include only some of the innumerable sights:  
  The middle of Lake Como, where its three branches come together, offers a spectacular view of the whole promontory of Bellagio, of the northern Grigna mountains overlooking Valsassina, and of the upper basin against the backdrop of the Alps if the skies are clear. It has the mildest climate and can be reached by boat.  
  www.taxiboat.it

  Besides the glorious views of the Lecco branch of the lake, which turns southwards, there are natural springs, like Fiumelatte, described by Leonardo da Vinci, and the impressive Orrido di Bellano (gorge), situated not far from the Renaissance Villa Monastero at Varenna.  

For more information visit:  
www.lakecomo.it
LATERAL MAXILLARY INCISOR IMPLANT:
— Key issues for esthetic success

PART II
— Prosthetic stages and long-term issues

Having discussed in the previous article (see editorial note), all of the preprosthetic stages for the replacement of a lateral maxillary incisor and having explained the surgical procedures required to improve the final esthetic outcome, in this second part, we discuss the prosthetic stages. Observation of clinical cases over a period of almost 15 years has made it possible to assess, over the different steps in the prosthetic chain, the impact of particular choices of components or clinical procedures on the final esthetic outcome of the gingival setting and the ceramic crown. As a result, for each clinical step, there are recommendations to help optimize and complete the surgical outcome and to ensure a long-lasting result.

In the last section, the esthetic outcome will be considered in relation to its medium- and long-term evolution, compared with the initial results. The effects of continuous tooth eruption and an analysis of different risk factors lead the authors to make clinical recommendations to minimize any negative effects.

Provisional prosthesis

A provisional prosthesis can be fabricated at different stages of treatment: when the implant is placed to provide an immediate temporary solution, when the implant is uncovered, or once the soft tissues have healed. A temporary abutment can be utilized, but this will involve greater manipulation of the subgingival components (Figs. 1a & b).

— One abutment, one time

The concept of the single abutment being seated early and definitively during implant treatment in order to preserve the attachment of soft tissues around the abutment is based on a publication many years ago by Abrahamsson et al.¹ For these authors, the multiple connections and disconnections of healing screws resulted in apicalization of the periimplant bone. This study is now considered to be biased because of the cleaning of healing screws with alcohol (which destroys the attached fibroblasts); nevertheless, it provided the basis for the one-abutment–one-time concept (OAOT) put forward by Maurice and Henry Salama at conferences from 2007. At present, the medical literature is generally in favor of this concept, even though research results are mixed:

— In dogs, the results of Iglhaut et al.² showed a highly negative outcome of connection and disconnection at four and six weeks, while in Alves et al.³ five such manipulations between 6 and 14 weeks had no negative consequences.
In humans, several recent studies have concluded that there is a vertical advantage of 0.5 mm, horizontal advantage of 0.3 mm, vertical advantage of 0.2 mm, and nonsignificant result for the OAOT protocol in different clinical situations.

In their 2014 review of the literature on factors influencing apicalization of peri-implant tissue, Iglhaut et al. documented interest in the concept of the single abutment and proposed recording the position of the implant at the time of placement. Thus, there is some evidence suggesting that it is desirable to limit the number of manipulations of the subgingival elements as much as possible, even though the literature is not unanimous in this regard.

The OAOT technique has a drawback pointed out by Piñeyro and Tucker: however, the increased risk of cement overflow where the abutment–crown limit is deeply buried. Different clinical strategies make it possible to apply the OAOT concept:

- The fabrication, using 3-D imaging, of a surgical guide and a machined abutment prepared during the preoperative stage makes immediate placement possible, but it is also more risky, since any error in the guide or any lack of precision in the placement could make the prepared abutment unusable.

- The same technique, starting with an impression at time of implant placement, is less risky, since the position of the implant has already been finalized.

Since these two techniques involve the collaboration of the laboratory, a simplified protocol was used for the majority of the 120 NobelActive implants (Nobel Biocare; 3 mm) placed over the past three years:

- Preoperative cone beam computed tomography imaging is used to determine whether a straight abutment or a 15° angulated abutment is the best choice for the specific clinical case.

- Radiographic monitoring makes it possible to check on the placement axis in the mesiodistal plane, and the use of a parallelism guide when the 2 mm drill is being used provides a check on the buccal–palatal plane. Once the implant is in place, an angulated prosthetic abutment is seated to optimize the rotational position of the implant, which is done to avoid, as far as possible, any adjustment to the abutment by grinding (Figs. 2a–c).

In order to assist with intraoperative fitting, the surgical kits contain sterile angled...
abutments, the incisal edges of which are slightly curved, which presents the rotational alignment of the implant better than a straight cylindrical abutment does (Fig. 3). An adjustment of a few degrees and a check of the occlusion make it possible to position the vestibular gingival edge perfectly and, most often, to use the abutment without any alteration, which substantially simplifies the rest of the prosthetic chain.

Keep manipulations of the abutment to a minimum.

In order to respect the principle of OAOT during the fitting of the provisional crown, a provisional resin coping is prepared on a straight or angled abutment, depending on the clinical requirement, along with a resin veneer created from a prosthetic tooth (Figs. 4a–c). The resin coping is bonded in the mouth to the veneer using a minimal quantity of resin in order to avoid direct pollution of the soft tissues by the cytotoxic resin monomer (Figs. 5a–e). The use of a standard abutment and a provisional coping makes the fabrication of temporary crowns very quick and simple while also respecting the principle of OAOT.

– Emergence profile

When putting the provisional tooth in place, it is preferable to give it an initial emergence profile that is concave in order to allow healing of the papilla with the maximum space available. A convex profile

Figs. 3
Surgical kit with 3.0, NP and RP angled abutments (NobelActive system).

Figs. 4a–c
Temporary coping created with a brush (UNIFAST III, GC) and a veneer (a). Initial clinical situation with a 15° angled abutment in place (b). Temporary coping in place (c).

Fig. 5a
Bonding of the coping and veneer. Palatal view showing the small quantity of resin used.

Figs. 5b–d
Bonded veneer, then relined and finished.

Fig. 5e
Provisional crown after cementing.
or an overcontour encourages apicaliza-
tion of the gingival margin, which is gen-
erally deleterious buccally (Figs. 6a–c).
After stabilizing the soft-tissue margin,
small amounts of resin placed mesially and
distally with a brush on the temporary
tooth allow some pressure to be placed on
the papilla according to the cervical con-
touring concept of Bichacho and Lands-
berg10 and, in this way, to optimize the fill-
ing of any gaps and the emergence profile.

Buccally, the gingival level or the crown
zenith can be moved by modifying the
temporary tooth (Figs. 6d & e). In order
to reduce any excess cement and to allow
it to escape during setting, a 0.75 mm hole
can be drilled on the palatal side in the in-
cisal half of the temporary crown.11

Optimize the emergence profile
by progressive modification of
the temporary crown.

– Taking impression

In order to comply with OAOT, the ideal,
provided that the abutment has not been
adjusted, is to take an impression of the
abutment. A resin impression coping fab-
ricated over an abutment identical to the
one seated in the mouth makes it possible
to transfer the position of the abutment
without unscrewing it (Figs. 7a & b). An
abutment and a laboratory copy are posi-
tioned in the impression and, if it is
thought that the abutment is not suitable
for the permanent prosthesis, one could
opt for a NobelProcera abutment (Nobel
Biocare) or a modified abutment (Fig. 7c).

Take an impression of the
abutment without removing it.

– Abutment

Material
According to several publications,9, 12, 13 ti-
tanium and aluminum and zirconium ox-
idates are the only materials that allow
attachment of soft tissues on the abut-
ment. For Van Brakel et al.,14 in a study on
humans, there is no difference between
titanium and zirconia regarding biology,
with just a slight advantage in favor of
zirconia for sulcular depth after three
months. Gold alloys cause apicalization of
the attachment to the titanium12 of the im-
plant, but this conclusion has been con-
tested by Linkevicius and Apse.15 A gold al-
loy supports less dental plaque after 4 h
in vitro,16 but more than titanium or zirco-
nia does after four days in vivo.17 Thus,
there is no consensus yet in the medical
literature concerning the superiority of
one material over another in terms of bi-
ology.

Zirconia and gold alloys have superior
esthetic qualities when the abutment
supports a glass-ceramic crown in vitro18
or in vivo19, compared with titanium. When
the implant site of the lateral incisor is
wide (> 6.5 mm), selecting a 3.3 or 3.5 mm
diameter implant makes it possible to use
zirconia abutments. However, the majority
of small-diameter implants on the market
do not include zirconia abutments in their
prosthetic ranges for reasons of mechan-
cal resistance. In such cases, commercial
titanium abutments or abutments made
by 3-D machining are used. In this situ-
ation, the thickness of buccal soft tissue
must exceed 2 mm, which is the requisite
dimensional specified by Van Brakel et al.20
to avoid there being any difference in light
reflection discernible by the human eye
between a titanium and a zirconia abut-
ment.

Shape
In cement-retained prostheses, excess ce-
cement has been found to be a cause of peri-
implantitis.21–28 Linkevicius et al.29 have
demonstrated in an in vitro experiment
that there is a correlation between the
depth of the abutment–crown joint and the amount of excess cement on the surface of the abutment. This is an argument in favor of the use of NobelProcera individual abutments. However, these individualized abutments often have significant undercut areas, which are recognized risk factors for the retention of intrasulcular cement. On small-diameter implants, the reduced dimensions of the abutments diminish the friction surface of the implant-supported crown and the creation of two small mechanical retentions in the incisal zone of the abutment reduces any loosening (Fig. 8).

**Maximize retention of small-diameter abutments.**

— Crown

Where edentulous gaps were narrow, 3 mm Nobel Active implants were placed and only titanium abutments, standard or NobelProcera, were used. Two types of crown are possible: metal–ceramic crowns or all-ceramic crowns.

— IPS e.max (Ivoclar Vivadent)

If the abutment is titanium, using an all-ceramic system can present restrictions related to the bucco-palatal thickness of the lateral incisor. When the tooth is thick, this prosthetic solution makes it possible to achieve an acceptable esthetic outcome (Figs. 9a–d). Conversely, when the thickness is less, this type of all-ceramic crown can sometimes result in more disadvantages than advantages from an aesthetic perspective. In such a case, for the coping in lithium disilicate, one has to use high-opacity ceramic of significant thickness in order to hide the titanium abutment as much as possible. This has the effect of reducing the thickness of the cosmetic ceramic and thus reduces its ability to mimic the appearance of adjacent teeth (Figs. 10a–d).

— Metal–ceramic crowns

Conversely, using metal-fused-to-porcelain crowns on narrow and small teeth makes it possible to reduce the thickness of the copings made from precious alloys or palladium (to 0.3 mm or 0.4 mm) and in this way to increase stratification (Figs. 11a–c & Figs. 12a–d). However, the transgingival area remains the weak point in this type of restoration with a risk of the grey color of the titanium abutment showing through when the periimplant mucosa is thin (see Fig. 33 in Russe & Limbour).

**Do not hesitate to use metal–ceramic crowns for small lateral incisors.**

— Monoblock screwed zirconia crown

The use of hexagonal implants measuring 3.3 mm externally or with an internal connection measuring 3.5 mm makes it possible to use zirconia abutments. In these circumstances, two options are possible, depending on the emergence position of the abutment screw: either a two-stage solution of a zirconia abutment supporting a cemented ceramic crown (Figs. 13a–d) or a monoblock crown screwed directly on to the implant (Figs. 14a & b). In these situations, the semitranslucent character of the material makes it possible to ensure optical continuity in both the coronal section and the gingival section, resulting in better esthetic integration.

— Cement

In order to reduce the visibility of titanium showing through when a glass-ceramic crown is used, an opaque white cement should be employed according to Dede et al. This involves a polycarboxylate cement (Poly-F, DENTSPLY DeTrey), selected initially for its theoretical ability to potentially allow detachment of the crown. Recent studies have demonstrated that polycarboxylate has greater tensile strength than does zinc oxyphosphate or glass ionomer. At the time of cementing, the cement-coated crown is placed on a replica abutment; any excess is removed before placing the crown in the mouth. This clinical technique has been proven beneficial for both its qualities of retention and reducing excess cement.

If standard abutments are used, then the crown limit can be considerably subgingival and it is then vital to use a minimum amount of cement and to remove any excess immediately. The washable nature of polycarboxylate cement immediately after placement can be an advantage for its removal.

— Esthetic outcome

When the esthetic outcome is evaluated according to the criteria specified by Fürhauser et al. and when particular attention is paid to the score for the papillae and the gingival level, use of small-diameter implants to replace lateral maxillary
Fig. 9a–d
IPS e.max high-opacity crown coping (a). Initial clinical result and radiograph (b & c). Result after one year (d).

Fig. 10a–c
Smile of female patient showing restoration of tooth #12 with IPS e.max (a). Close-up photograph: The opaque armature is visible (b). Radiograph (c).

Fig. 10d
The esthetic finish of the veneer on tooth #22 is superior to that of IPS e.max on tooth #12.

Fig. 11a–c
Metal–ceramic crown on master cast (a). Clinical result: The mesial and distal papillae are aligned (b). Radiographic result (c).

Fig. 12a–d
Master cast with the metal–ceramic crown on a modified abutment (a & b). Clinical result: The papillae are aligned (c). Radiographic result (d).

Fig. 13a–d
NobelProcera screwed zirconia abutment (a) and all-ceramic crown (b). Screwed abutment in the mouth (c). Esthetic outcome (d).

Fig. 14a & b
One-piece zirconia crown (a). Esthetic integration (b).
incisors appears to result in an improvement compared with wider implants. The margin of the papilla and the position of the collar, in relation to the contralateral incisor, are the two principal issues presented by implant replacement of a lateral incisor (Fig. 15). In most cases, the mesial papilla, between the central incisor and the lateral incisor, is at an almost normal height, whereas the distal papilla, between the lateral incisor and the canine, is often shorter and displays a slight vertical deficit (Fig. 16).

— Initial evolution

When the implants are well positioned and the buccal soft and hard tissue are thick, the esthetic outcome is lasting. In the early years, an improvement of the outcome may occur owing to the soft tissue filling the prosthetic embrasure (Figs. 17a & b).

— Continuous eruption

Since the 1980s, authors such as Levers and Darling36 have described the phenomenon of continuous eruption, which results in a verticalization of the maxillary incisors. The osseointegration of implants prevents them from following this migration and, over time, the lateral incisors can end up in a more apical and buccal position than the central incisors. This phenomenon is sometimes perceptible after some years have passed, whatever the age when the implants were placed (Figs. 18a & b). Thus, the organization of anterior guidance becomes particularly important, since rapid movement of the central incisors can occur if these are not in occlusion when the implants are placed. During orthodontic treatment, balanced anterior guidance for the central incisors and the canines will be one of the major objectives for the orthodontist. If there is bilateral agenesis, the symmetry of the smile will be maintained and the situation will be esthetically more favorable than for a unilateral replacement. After some years, the discrepancy may become quite significant and may be present just in the vertical plane or may be a combination, both vertical and horizontal (Figs. 19a–c). It was thought that this phenomenon was the result of placing implants too early, but in 2004 Bernard et al.37 showed that there was no difference between a group of young adults and a group of adults in terms of infraocclusion of implant-supported crowns in the esthetic region. In describing the problems found in implant-supported anterior restorations (bluish gingiva, infraocclusion, exposure of abutment), Zachrisson38 poses the question: Is an implant the best solution for treating agenesis?

Warn the patient of the negative impact of continuous eruption on the esthetic outcome.

— Risk factors

Andersson et al.,39 who followed 34 patients over a period of 17–19 years, showed that severe infraocclusions (> 1 mm) affected 35% of the patients. They made several findings, including the following:
Women were affected more than men.

- It was more noticeable in long rather than short faces.
- There was no correlation with age.
- The patients were more satisfied with the results than were the practitioners.

The findings of the same researchers were presented at the 2012 Academy of Osseointegration annual meeting in Phoenix, Ariz., U.S., by Torsten Jemt, who attributed implant-supported crown infraocclusions to posterior mandibular rotation resulting in verticalization of natural incisors that is not followed by the crowns on the implants. In the results reported, 19 out of 69 cases presented infraocclusions of more than 1 mm and the phenomenon affected twice as many women as men.

A recommendation has been made by the practitioners of the Brånemark clinic in Gothenburg, Sweden, to place implants in a palatal position in anticipation of possible verticalization of the central incisors. Such placement also facilitates any prosthetic adjustment.39

Favor a palatal positioning of implants.

-- Conclusion

Replacement of a lateral maxillary incisor is a difficult task. The great visibility of the tooth in the smile and comparison with the contralateral tooth in the same view are factors with intrinsic esthetic risks. In both parts of this article series, emphasis has been placed on the most difficult situations when the lateral incisor is small. In such circumstances, any lack of precision in the positioning has powerful implications for the esthetic plan. In this situation, using small-diameter implants would appear to offer advantages for the height of the papillae around the implant.

In about one-third of cases, continuous maxillary eruption undermines the initial esthetic outcome, which may result, at the very least, in having to change the crown on the implant. This change to the esthetic outcome should form part of the information provided to patients before starting treatment.40

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Editorial note: A list of references is available from the publisher. The first part of this article series, titled “Lateral maxillary incisor implant: Key issues for esthetic success,” was published in Clinical Masters18, March 2015, Volume 1, Issue 1.

Conflict of interest: The authors declare that they have no conflict of interests relating to this article.
Location
The BORG Center is located in Barcelona, a city with a rich cultural heritage and known for its Catalan culture and distinctive architecture, including several UNESCO World Heritage Sites. It is a popular tourist destination and boasts one of the best beaches in the world.
www.borgbcn.com

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Where to stay
AC Hotel Gavà Mar, has a seafront location in a quiet area close to the BORG Center, but a little far away from the center of Barcelona.
www.marriott.com | 4-star

Majestic Hotel & Spa, offers luxurious accommodation in a neoclassical building on Passeig de Gràcia, near shopping areas in the center of Barcelona
www.hotelmajestic.es | TripAdvisor Certificate of Excellence | 5-star

W Barcelona, right on the beach and 30 minutes from the BORG Center, commands fantastic views over Barcelona and has a magnificent design.
www.w-barcelona.com | TripAdvisor Certificate of Excellence | 5-star

Hotel 1898, on La Rambla, is housed in a restored colonial-style nineteenth-century building.
www.hotel1898.com | TripAdvisor Certificate of Excellence | 4-star

Sidorme Viladecans is quite new and a 5-minute taxi ride to the BORG Center.
www.sidorme.com | TripAdvisor Certificate of Excellence | 3-star

Where to eat
ABaC Restaurant serves Mediterranean/ Spanish fusion cuisine.
www.abacbarcelona.com | 2 Michelin stars

Freixa Tradició is a very small and old restaurant offering traditional Catalan food.
www.freixatradicio.com

Ziryab Fusion Tapas Bar serves Spanish cuisine with a Middle Eastern twist.
www.ziryab.es

Silvestre is an elegant restaurant that serves international and traditional cuisine with the option of half-portions for every dish.
www.restaurante-silvestre.com

Tast-Ller is a small, exclusive Mediterranean restaurant located down a side alley.
www.tast-ller.com

What to see and do
Take a stroll down La Rambla, the world-famous boulevard stretching about 1.2 kilometers all the way to the Mediterranean Sea.
Wander through the Barri Gòtic (Gothic quarter), the center of the old city.
Visit the Museu Nacional d’Art de Catalunya (Catalonia national art museum).

— Dr. Xavier Vela Nebot obtained his degree in dentistry and medicine from the University of Barcelona. He has a private practice in Barcelona dedicated to implantology and prosthetics. He is a co-founder of the BORG Center, conducts research and regularly publishes articles in leading international journals. He has lectured at prominent national and international symposiums.

— Dr. Xavier Rodríguez Ciurana obtained his degree in medicine and surgery from the University of Barcelona. He has a private practice in Barcelona. He is an associate professor at the European University of Madrid in Spain and is co-founder of the BORG Center.
See Antoni Gaudí’s many masterpieces, seven of which are on the UNESCO World Heritage List, the most famous probably being the Sagrada Familia basilica and the beautiful Park Güell, demonstrating perfect harmony of nature and architecture. 

A UNESCO World Heritage Site, Palau de la Música Catalana is a concert hall exemplary of art nouveau architecture. Some of the most important craftsmen and artists of the time were involved in its creation. Housed in five Catalan-Gothic palazzos dating from the thirteenth and fourteenth centuries, the Museu Picasso is a museum of the artist’s formative years.

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Previous participants have enjoyed a visit to the FC Barcelona Museum and attending a game as well. www.fcbarcelona.com

For more information visit: www.barcelonaturisme.com

— The BORG Center, or Barcelona Osseointegration Research Group, is focused on research in oral implantology and its various clinical applications. The center was established in early 2005 when four specialists in oral implantology developed a common protocol with good results to demonstrate that in cases in which the diameter of the pillar is smaller than the diameter of the implant bone loss is ostensibly lower. This research, titled “Benefits of an Implant Platform Modification Technique to Reduce Crestal Bone Resorption,” was published in Implant Dentistry in 2006. Since then, they have lectured worldwide and have produced and collaborated on a number of publications. We enjoy our work and are eager to share it with you.
FIVE KEYS
— to more predictable esthetic restoration of anterior implants

Introduction

Dental implants have enabled clinicians to replace missing teeth and return function and harmony to patients owing to their high predictability.1 However, it can be challenging to create implant-supported restorations that emulate the natural dentition. Among the guidelines that have been proposed for achieving esthetic excellence, many focus on maintaining or enhancing the volume of periimplant soft and hard tissue.2 This paper describes five keys to achieving and maintaining dento-gingival harmony and obtaining highly esthetic anterior implant restorations. Use of an implant that facilitates adherence to several of these principles is illustrated with a case description.

The five keys

— 1. Tissue optimization (Fig. 1a)

Several studies have documented post-extraction resorption patterns that demonstrate horizontal and vertical bone loss during the first year after extraction.3, 4 Some bone resorption has been described at sites where the extracted teeth were immediately replaced with implants.5 The objectives of tissue optimization are to diagnose the volume of soft and hard tissue and, in the absence of an adequate amount, prepare for augmentation of the volume. Augmentation procedures may be beneficial in preventing black triangles and creating natural emergence profiles.5, 6, 7 An early implant placement protocol8 should be applied when tooth extraction is required at a site with a thin gingival phenotype. Although this approach does not allow adequate time for bone to form in the extracted site, it provides a soft-tissue seal by primary intention.

— 2. Gingival remodeling (Fig. 1b)

Once the volume of the gingival tissue above or adjacent to the implant has been optimized, some reshaping of the tissue should be considered. Use of an ovate pontic has been suggested to support the gingival tissue coronal to the implant shoulder, creating pseudopapillae and a natural emergence profile. The ovate pontic may also expose the submerged implant and avoid the need for a second surgery to obtain access to the cover screw. Avoiding a second surgery will help to preserve the gingival architecture and minimize soft-tissue scar retraction.10

The use of provisional restorations to sculpt the soft tissue without causing recession or retraction is fundamental. Most fixed and removable prostheses can accomplish this goal.10 Another technique is to use cemented fixed provisional restorations and minimally invasive palatal preparations.11 Pressure should gradually be imposed on the soft tissue from the palatal to the labial aspect and the mesial to the distal aspect in order to displace tissue volume toward the areas adjacent to the prosthetic crown, where papillae and convex contours are desired for a natural emergence profile.

— 3. Handling reduction (Fig. 1c)

Once an ideal tissue form has been obtained, it must be preserved and stabilized. Frequent disconnection and reconnection...
of the abutment has been associated with detrimental effects on the periimplant bone. It creates a soft-tissue wound and triggers subsequent bone resorption as a proper biologic dimension of the mucosal barrier attachment to the stable implant surface is re-established. In order to avoid disturbing the mucosal periimplant seal that preserves the crestal bone level, a customized abutment for a cement-retained prosthesis should be placed with the objective of avoiding repeated implant-level impressions and try-ins. An abutment-level impression should be taken. When impressions are taken at the time of implant placement and further abutment manipulation can be avoided, less bone resorption has been shown to result.

4. Effective component design (Fig. 1d)

The implant macrodesign and, in particular, the design of the implant–abutment junction (IAJ) are critical in preventing the loss of crestal bone. Numerous publications have demonstrated that some alveolar bone resorption occurs around the IAJ of platform-matched implants when they are exposed to the oral environment. It has been postulated that the first bone-to-implant contact begins around 1.5–2 mm apical to the IAJ or to the first implant thread. About 1.4 mm of horizontal resorption occurs. A different bone response has been documented when platform-switched implants are used. A recent systematic review and meta-analysis showed that significantly less bone resorption occurred when this IAJ design was employed. Use of the 4/3 Biomet 3i Tapered Implant (BIOMET 3i) facilitates following several of these keys to achieve more predictable esthetic restoration of anterior implants. The design incorporates platform switching, with a 3.4 mm platform dimension in order not to impinge on the interdental space.

Histological investigation has found that platform switching appears to affect the location of the circularly oriented collagen fibers that surround implant abutments and apparently stabilize the connective tissue and underlying alveolar crest. While these fibers have been found at the level of the first thread of nonplatform-switched implants, they have developed at the IAJ of platform-switched implants. The horizontal platform of the platform-switched implants appeared to provide mechanical retention for the circular fibers, allowing them to develop more coronally than in standard implants. The abutment design too can help to stabilize the connective tissue above the IAJ and preserve alveolar bone at the platform level. One concave design has been proposed that features a circumferential macrogroove that creates space for soft tissue. It arguably creates a ringlike seal that, after tissue maturation, may stabilize the connective tissue adhesion. Connective tissue stabilization has also been demonstrated when using a narrow laser microgrooved cylindrical abutment.

The implant–abutment connection too appears to have a significant impact on periimplant crestal bone levels. Internal connections have been demonstrated to better maintain bone. Finally, the design of the prosthetic crown and its relationship to the implant abutment are essential factors for restoring tooth anatomy and function. The crown should provide space for fiber stabilization between the cervical contours and the implant platform.

5. Abutment surface cleanliness (Fig. 1e)

Implant abutments are transgingival devices that interact in their most cervical region with the surrounding tissue, mainly connective tissue underneath the gingiva. Abutments allow for the re-establishment of the biologic width: as cells attach, the
epithelial junction forms, and the underlying connective tissue subsequently stabilizes. The abutment material may influence cellular attachment processes. Surface contamination occurring after laboratory or clinician manipulation or reuse of the abutments has been shown to have a detrimental effect on cellular attachment. Multiple protocols, including rinsing with saline solution or hydrogen peroxide, autoclave sterilization and ultrasonic treatment, have been devised to restore the original biocompatible abutment surface composition without changing the surface topography. Most have failed to eliminate the contaminants, and some have worsened the cell adhesion. However, exposure to ozone has been demonstrated to eliminate plaque film completely, and the ability of chlorhexidine to decontaminate abutment surfaces has also been demonstrated. Providing a biocompatible environment before abutments are placed.

Fig. 2 The patient was a 29-year-old woman who presented with pain in her maxillary central incisors.

Fig. 3 Radiographic examination revealed the presence of periapical lesions. The teeth were deemed to be non-restorable.

Fig. 4 The central incisors wereatraumatically extracted, and the sockets were immediately filled with collagen sponges to aid with clot stabilization.

Fig. 5 The patient returned five weeks after the extractions for early placement of implants.

Fig. 6 Reflection of a flap revealed the absence of the labial bony plate. Osteotomies were created, and two 3i Tapered Implants, both 4 mm in diameter and 13 mm in length with a 3.4 mm platform, were placed.

Fig. 7 Good primary stability was obtained for both implants, but large labial defects were present, as demonstrated by this occlusal view. Impressions were taken immediately after implant placement in order to prepare the definitive prosthetic abutment.

Fig. 8 Along with implant placement, guided bone regeneration was carried out using Endobon Xenograft Granules and an OsseoGuard Membrane (BIOMET 3i). A connective tissue graft was also performed.

Fig. 9 Occlusal view after implant placement and grafting.

Fig. 10 Three months after placement of the implants, the provisional prostheses were removed. The shape of the soft tissue was progressively modified to improve the emergence profile and to expose the cover screws in a nontraumatic second surgery (soft-tissue remodeling technique).
in contact with the gingival tissue can promote earlier tissue stabilization. Eliminating or reducing the role of disturbing agents is thus an important goal. Figures 1 to 16 illustrate the use of a 4/3 3i Tapered Implant (platform-switched) to implement several of the five keys in two compromised and esthetically demanding sites.

**Conclusion**

Management of anterior implant restorations demands a highly esthetic approach in order to obtain successful outcomes. Multiple interrelated factors influence the relationship between the white esthetics of the restoration and the pink esthetics of the surrounding gingival tissue. None of these factors should be considered in isolation. Only by coordinating their application can more predictable and harmonious esthetic restorations be created. The use of the 3i T3 Tapered Implant and the marginless abutment can help clinicians to follow the five steps explained in this article in order to obtain better esthetic results for implant-supported restorations.

**Fig. 11**
Four months after being placed, the implants were uncovered. GingiHue Abutments (BIOMET 3i), modified in the laboratory to achieve a 6° taper and margin-free restoration, were placed. This is the first and only abutment swap (handling reduction).

**Fig. 12**
The definitive abutment screws were tightened to 20 N cm, and the screw access openings were restored with composite in preparation for placing the cement-retained provisional bridge.

**Fig. 13**
The patient wore the implant-supported fixed resin bridge for three months, enabling further maturation of the soft tissue.

**Fig. 14**
Eight months after placement of the implants, the soft tissue had further matured and stabilized, and the definitive two-unit full-ceramic bridge was fabricated.

**Fig. 15**
Nine months after placement of the implants, the definitive zirconia bridge was cemented in place.

**Fig. 16**
Radiograph of the definitive two-unit bridge.

*Editorial note: A list of references is available from the publisher.*
The Steigmann Institute is a private teaching institution founded in 2006. Its mission is to teach dentists all aspects of dental implantology, with the focus on soft-tissue management and bone regeneration.

Dr. Marius Steigmann received his degree in dental medicine in 1987 and his Ph.D. in 2005, both from the University of Medicine and Pharmacy of Timișoara in Romania. He is the founder and director of the Steigmann Institute.

Location
The Steigmann Institute is located in the popular vacation town of Neckargemünd along the Neckar River. The town has more than a thousand years of history and many of the seventeenth-century buildings have retained their original charm. There is a lively cultural scene with a wide range of activities, and its proximity to Germany’s famous university town of Heidelberg is a great attraction.

www.steigmann-institute.com

How to get there
Heidelberg is located 1 hour south of Frankfurt am Main. You can book a train ticket to Heidelberg on the national railway website: www.bahn.de.
Alternatively, you could take a Lufthansa airport shuttle from Frankfurt Airport to Heidelberg. The bus route terminates at the Crowne Plaza Heidelberg City Centre hotel. Buses run every hour between 7:00 a.m. and 10:15 p.m. and can be found right across from the Frankfurt Airport meeting point in Terminal 1, Hall B, Exit B4. Seats are guaranteed if they are reserved three days prior to your arrival. The exact bus schedule and information on reservation procedures are available at www.transcontinental-group.com.

Where to stay
Both in the heart of the city and within walking distance of the Old Town, Heidelberg University and Heidelberg Castle are the following:
Crowne Plaza Heidelberg City Centre, is a hotel providing centrally located stylish accommodation.
www.crowneplaza.com | TripAdvisor Certificate of Excellence | 4-star

Europäische Hof Heidelberg, overlooking the city gardens, is a luxury hotel dating back to 1865 in the heart of Heidelberg’s historic centre.
www.europaeischerhof.com | TripAdvisor Certificate of Excellence | 5-star

Heidelberg Marriott Hotel looks out over the beautiful Neckar River and is close to the university and a short distance from the Old Town.
www.marriott.com

Holländer Hof Hotel is located in the romantic heart of Old Town Heidelberg opposite the Old Bridge, offering a beautiful view over the Philosophers’ Way and the Neckar River.
www.hollaender-hof.de | TripAdvisor Certificate of Excellence | 3-star

Another option is a vacation apartment at the Bauer winery, where you can choose from four modern apartments for two to five persons.
www.heidelberger-dachsbuckel.de

Backmulde is a restaurant in the historic Hotel Backmulde offering regional cuisine.
www.gasthaus-backmulde.de

Wirtshaus zum Nepomuk provides traditional fare in a tavern atmosphere (highly recommended for traditional German cuisine).
www.altebruecke.com

Carl Theodor Restaurant & Destillathaus is a small restaurant located in a protected monument building next to the Old Bridge providing German cuisine.
www.carltheodor-restaurant.de
Seppl is one of the oldest student pubs in Heidelberg and serves regional specialties with a good range of home-brewed beer and great glühwein.

www.heidelberger-kulturbrauerei.de

Mensurstube, one of two restaurants in the Hirschgasse Hotel, serves typical German food.

www.hirschgasse.de

What to see and do
The ruins of the once-grand Heidelberg Castle rise up on a rocky hilltop over the city. The castle holds the largest wine barrel in the world, standing seven meters high and eight and a half meters wide, and holding 220,000 liters of wine. In the castle grounds is the Deutsches Apotheken-Museum, which recounts the history of Western pharmacology.

Heidelberg Old Town is filled with architectural gems. Visit the town hall, the Old University and historic buildings like the 1592 Renaissance townhouse called “Knight St. George,” and enjoy the open-air cafés dotted along the market squares. The Old Town is also home to a third of all the shops in Heidelberg.

Untere Straße, a narrow cobbled street that runs parallel to the river and the main pedestrian street in the Old Town, is filled with great bars, coffee shops and inexpensive eateries.

The Gothic Heiliggeistkirche, Heidelberg’s famous church, was at one time used by both Catholics and Protestants. The top of its spire offers a bird’s-eye view of the town.

According to tradition, Heidelberg’s philosophers and university professors would walk and talk along the Philosophers’ Way, which runs along the side of the Heiligenberg. It passes through the forest and commands panoramic views of the castle.

The university library, built in Wilhelmian style, holds superb collections, including rare books and prints in its exhibition room.

A boat trip down the Neckar offers a different view of the townscape.

www.weisse-flotte-heidelberg.de

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Dr. Didier Dietschi received his D.D.M. in 1984, his M.D. in 1989, his Ph.D. in 2003 and his habilitation qualification (postdoctoral) in 2004, all from the University of Geneva. He is currently a senior lecturer at the university and is an associate professor at Case Western Reserve University in Cleveland, Ohio, U.S. Dr. Dietschi is in charge of anterior adhesive restorations and periodontal and implant surgery at the Geneva Smile Center.

— Dr. Didier Dietschi

Location
The Geneva Smile Center is located on Lake Geneva, Europe’s largest Alpine lake, near its landmark fountain. The main shopping area in Geneva is just a few minutes away from the center. Geneva, a trendy paradise, is in the French-speaking part of Switzerland and home to the European headquarters of the United Nations, among over 200 international organizations. It is a city of culture and art and one of the greenest cities in Europe with 20 percent of its green areas, earning it the appellation “City of Parks.” It is close to some of the best ski areas in the Alps.

How to get there
The center is located seven kilometers from Geneva International Airport. It will take about 30 minutes to reach the center by taxi in good traffic conditions. An alternative is to take the No. 10 bus to the bus stop near Genève-Cornavin railway station (the stop is called “22-Can-tons”), change to the No. 9 bus and get off at Place des Eaux-Vives.

Where to stay
The following hotels are all located close to the Geneva Smile Center and the town center:

- Hôtel de la Paix, built in 1865 and overlooking the lake, offers refined luxury with a contemporary design that retains the elegance of the original Italian architecture. [www.ritzcarlton.com](http://www.ritzcarlton.com) | TripAdvisor Certificate of Excellence
- Hôtel de la Cigogne, located between the Old Town and Lake Geneva, occupies a charming historic building and its accommodation is distinguished by luxury, elegance, comfort and artistry. [www.cigogne.ch](http://www.cigogne.ch) | TripAdvisor Certificate of Excellence
- Swissotel Métropole, on the rue du Rhône, the most luxurious shopping street in Geneva, is a stylish boutique hotel with a panoramic view over Lake Geneva. [www.swissotel.com/hotels/geneva](http://www.swissotel.com/hotels/geneva) | TripAdvisor Certificate of Excellence
- Hôtel Longemalle, close to the lake and the Jardin Anglais, is a haven of tranquility on

—— The Geneva Smile Center

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<th>Location</th>
<th>How to get there</th>
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<td>The center is located seven kilometers from Geneva International Airport. It will take about 30 minutes to reach the center by taxi in good traffic conditions. An alternative is to take the No. 10 bus to the bus stop near Genève-Cornavin railway station (the stop is called “22-Can-tons”), change to the No. 9 bus and get off at Place des Eaux-Vives.</td>
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<th>Where to stay</th>
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<td>Hôtel de la Paix, built in 1865 and overlooking the lake, offers refined luxury with a contemporary design that retains the elegance of the original Italian architecture. <a href="http://www.ritzcarlton.com">www.ritzcarlton.com</a></td>
<td>TripAdvisor Certificate of Excellence</td>
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Where to eat

Vertig’O, a restaurant at the Hôtel de la Paix offering gourmet French cuisine www.ritzcarlton.com | 1 Michelin star

Le Patio, cuisine almost exclusively based on lobster and beef www.lepatio-restaurant.ch

Brasserie Lipp, a typical French brasserie www.brasserie-lipp.com

THAI, authentic Thai gastronomy www.thai-geneve.com

La Finestra, a cozy restaurant in the Old Town serving delicious cuisine with an Italian flavor www.restaurants-geneve.ch

Café Papon, casual French restaurant in the Old Town www.cafe-papon.com

What to see and do

Follow the story of the Genevan humanitarian movement by visiting the International Red Cross and Red Crescent Museum.

Visit the Globe of Science and Innovation at CERN, the world’s largest laboratory for particle physics.

Climb the 157 steps of the twelfth-century Cathédrale Saint-Pierre for a breathtaking view of the city.

See the over 6,500 flowers and plants of the Flower Clock, a fine example of Swiss precision, in the Jardin Anglais.

Take a guided tour of the Palais des Nations, which houses the United Nations Office at Geneva (www.unog.ch).

Go skiing in the Alps. Chamonix and Mont Blanc are located 80 kilometers away. Megève, 70 kilometers away, originally conceived in the 1920s as a destination for the aristocracy, is a famous and fancy ski resort.

A lake tour (www.keytours.ch) offers a wonderful way to discover Geneva.

Explore the shops and antique dealers of Carouge, close to the city centre, by day and its trendy bars by night.

Visit the luxury boutiques along the rue du Rhône to see timepieces of beauty and indulge at the master chocolatiers.

Go on an outing to the village of Dardagny to walk among the vineyards and sample the local wines.

For more information visit: www.geneve-tourisme.ch
NO-PREP INTERCEPTIVE REHABILITATION
— of tooth wear using a free-hand technique driven by a functional wax-up

Dr. Didier Dietschi, Switzerland

Treatment rationale
Excessive abrasion (attrition) and erosion are two common conditions affecting dental hard tissue and occur in an increasing number of patients.1,2 Both can be considered growing challenges in dentistry, because with such patients, especially in cases of severe parafunction, the etiology can rarely be successfully and permanently eliminated.3–5 Therefore, continuous monitoring to control related pathologies is required.

The most frequent causes of erosion are unbalanced dietary habits with a high consumption of acidic food or beverages (such as fruit, carbonated drinks, fruit juices and vinegar), as well as abnormal intrinsic acid production, such as in bulimia nervosa, acid reflux and hiatal hernia. Insufficient salivary flow rate or buffer capacity and, in general, salivary composition changes induced by various diseases, medications and aging are other etiological co-factors.6–9 As regards abrasion, awake and sleep bruxism are two different forms of parafunctional activities that can severely affect tooth integrity.4,5 Preventive and restorative measures are therefore mandatory to correct and limit the extent of further tissue and restoration destruction. An important clinical finding is that a large number of patients affected by hard-tissue loss present combined etiologies, challenging the dental team to determine a multifactorial preventive and restorative approach.1–9

The dental consequences of abrasion and erosion are manifold and involve a loss of enamel, with progressive exposure of large dentin surfaces, which significantly affects the occlusal, facial and lingual tooth anatomy and has biological consequences too. Objective symptoms or complaints reported by patients are shortening of teeth, discoloration, tooth displacement, dentin sensitivity, as well as an increased risk of decay and premature loss of marginal adaptation of the restoration. The significant impact of tooth wear on occlusion, function and esthetics leads the patient to seek advice and intervention. The biomechanical challenge shall entail a range of treatments involving different specialties, from preventive measures to full-mouth rehabilitation. Intermediate stages (slight to moderate erosion or abrasion) require other clinical measures, such as various forms of adhesive and partial restorations. The aim of this paper is to present a sound clinical concept for addressing various forms of early restorative intervention and their potential to restrict ongoing tissue destruction.

A comprehensive treatment approach
The modern approach to the treatment of tooth wear aims to stop its progression before full prosthetic rehabilitation becomes indicated, which would require the removal of large amounts of additional tooth substance with potential biological complications10,11 and a rather inadequate biomechanical rationale. The approach involves three steps:

1. a comprehensive etiological clinical investigation, including diet analysis and identification of general/medical and local risk factors;
2. treatment planning and execution, including a proper functional and esthetic wax-up defining the new smile line and tooth anatomy, transferred then to the mouth with a combination of direct and indirect restorations; and
3. a maintenance program, including a protective night guard and, potentially, repair or replacement of restorations over a medium- or long-term time frame.

The restorative options at hand comprise direct partial composite restorations, indirect partial composite or ceramic restorations, and indirect full-ceramic restorations. Considering the more dramatic failure patterns observed with conventional prosthetic restoration,10,11 using more conservative restorations, such as partial direct and indirect restorations, appears to have irrefutable advantages and promising outcomes in the treatment of severe abrasion and erosion.12–14
Dahl’s concept and controlling the vertical dimension of occlusion

The idea of increasing the vertical dimension of occlusion (VDO) to treat or restore patients with abnormal tooth wear has been described and applied for a long time; one of the first clinicians to promote this technique was Dahl, who published many articles on this topic.15 His approach was to use a metal appliance to elevate the occlusion and allow teeth to move passively until they are again in occlusion and then create space to restore the teeth stabilized by the appliance.15 The dental movements are intended to occur by combined supra-eruption of occlusally free teeth together with simultaneous alveolar growth and intrusion of teeth maintaining contacts. It was shown that such phenomena would occur in a significant proportion of patients treated according to this concept16 and the outcomes of such treatment have been corroborated by several recent papers and review articles.15–19 Increasing the VDO is a key parameter for reversing and preventing the consequences of pathological wear and erosion.20–25 The passive eruption that accompanies the continuous tissue destruction and loss, tremendously restricts the space available for restorations, which due to their limited thickness, would be very fragile or otherwise require unnecessary removal of the residual tooth structure. Recent clinical reports have largely validated this treatment approach,23–25

Treatment outline and restorative options

The decision regarding the optimal restorative choice is usually based on the pre-existing dental condition (presence of decay, restoration, vital or nonvital status), as well as the amount and localization of tissue loss. This means that various restorative options have to be considered and that treatment planning is highly individual (tooth-specific).

The therapeutic scheme is logically oriented toward re-establishing first proper length of the central incisors and anterior guidance, governing thereafter the new VDO. Proper anterior tooth anatomy and function are designed according to objective esthetic guidelines,26 existing and former tooth anatomy, as well as functional and phonetic components. The first step entails producing study casts in the form of a partial (in the case of moderate posterior tissue loss) or full-mouth wax-up (in the case of advanced generalized tooth wear or erosion; Fig. 1).

Direct composite option

The direct composite option is logically indicated for all forms of moderate to intermediate tissue loss or destruction.13–16 Among the benefits of a direct composite restoration are its highly conservative approach, the ability to replace or reshape small portions of the tooth, reparability, simplified replacement and relatively limited cost (Fig. 2). Conversely, it is more technique sensitive and might result in thin layers of material over some surfaces, placing them mechanically at risk. When using a sculpting technique, proper anatomy can be created also with a direct technique, favoring the selection of a highly filled material with a firm consistency.27–29 In the case illustrating this treatment modality, a highly filled homogeneous nanohybrid material (inspicro, Edelweiss DR) was used owing to its firm consistency, favorable for free-hand sculpting and modeling (Figs. 2f–l).

Indirect composite option

The indirect option is logically preferred when larger restorations or tissue destruction of a greater severity is present. It also provides greater control of the anatomy and occlusion in complex or advanced cases. Nevertheless, one should not neglect the direct option only in favor of this last parameter, as occlusion seems not to play a major role in the origin of parafunction.4, 5, 30–32 Since direct and indirect techniques can be used together to treat the same patient, when indirect restorations are chosen, they have to be fabricated first, at the new VDO, and then direct composites placed.

Material selection

Today, the debate about whether ceramics or composite is best indicated for such restorations is sometimes based on personal experience and belief, rather than on scientific or clinical evidence. The rather abundant clinical literature dealing with the clinical behavior of composite and ceramic inlays and onlays has not shown a major advantage of either material.33, 34 I clearly favor composite in the context of tooth wear. Were ceramics to be chosen, the Empress material (Ivoclar Vivadent), which has shown limited annual failure rates,35 and, of course, today’s new lithium disilicate pressed ceramic (IPS e.max Press, Ivoclar Vivadent), with improved flexural strength and fatigue resistance,36 would be considered the best choice.

Longevity of restorations placed to correct severe tooth wear and erosion

Clinical studies have demonstrated that the performance of composite in the treatment of advanced tooth wear is adequate and that partial fractures represent the most likely complication. These can be corrected by a repair or uncomplicated replacement of the restoration.27–29 The ten-year survival rate of porcelain-fused-to-metal crowns has been proved to be slightly superior to that of composite restorations, but with much more severe complications: Porcelain-fused-to-metal failures led mainly to endodontic treatments or to extractions, while composite failures or fractures could be either repaired or replaced.40 This again demonstrates the reason the conservative and adhesive approach is favored for treating all kinds of mild to moderate forms of tooth wear and erosion.

Conclusion

The incidence of tooth wear represents an increasing concern for the dental team and has multifactorial origins. Behavioral changes, an unbalanced diet, various medical conditions and medications inducing acid reflux or influencing salivary composition and flow rate trigger erosion. In addition, awake and sleep bruxism are widespread functional disorders that cause severe abrasion. It is then increasingly important to diagnose early signs of tooth wear so that proper preventive and, if necessary, restorative measures are taken, with the focus on biomechanics and long-term tissue preservation.

Acknowledgments

I would like to thank Serge Erpen (Oral Pro, Geneva, Switzerland) for the fabrication of the wax-ups presented in Figures 2d and f.
Fig. 1
Comprehensive treatment scheme for anterior and posterior tooth wear or erosion. The length of the anterior teeth is reduced by combined wear or erosion (1). The VDO needs to be augmented (2). On the models and based on a wax-up, a new anterior guidance and smile line are established (3), from which an index is made and transferred to the mouth when proceeding with posterior restorations (4). Three different conditions are encountered in the posterior areas:

(a) no or minimal tooth loss (occlusal stops are made with composite of any type);
(b) moderate tooth loss and/or small to medium-sized restorations (occlusal morphology is re-established with a hybrid composite and direct technique); and
(c) severe tooth loss and large metal-based restorations (occlusal morphology is re-established with indirect tooth-colored restorations—overlay).
Figs. 2a–c
Pre-op situation showing moderate to severe tooth wear, due to combined abrasion and erosion etiologies. However, the amount of tissue loss does not speak in favor of a conventional prosthetic solution; rather, an interceptive solution using direct composite restorations would be used in this case.

Figs. 2d & e
Pre-op diagnostic wax-up, creating a new and improved occlusal and anatomical posterior scheme. The full-mouth wax-up is made prior to treatment and establishes the new VDO. Silicone indexes can serve to build up lingual and buccal cusps to the correct level if needed.

Figs. 2f–l
Details of the treatment performed in the lower left and upper left quadrants, respectively. After rubber dam placement, amalgam fillings were removed and tooth surfaces prepared and cleaned with sandblasting, before applying composite. A highly filled homogenous nanohybrid material (inspiro) was used and sculpted before light curing, enabling proper anatomy and function to be established.
Figs. 2f–l
Details of the treatment performed in the lower left and upper left quadrants, respectively. After rubber dam placement, amalgam fillings were removed and tooth surfaces prepared and cleaned with sandblasting, before applying composite. A highly filled homogenous nanohybrid material (inspiro) was used and sculpted before light curing, enabling proper anatomy and function to be established.
The same treatment sequence was applied to all of the lower and upper quadrants. These images show that composite serves both to fill existing cavities and to replace eroded or worn tissue, creating better function, restabilizing proper anatomy and esthetics, and finally protecting damaged tissue from further degradation. This is an ideal treatment protocol for moderate tooth wear combined with small Class I and II cavities.

Smile and occlusal views of this full-mouth rehabilitation, using only direct restorations. Such an approach is highly conservative, comfortable for the patient owing to the short treatment time, and cost-effective.
Figs. 2o–q
Smile and occlusal views of this full-mouth rehabilitation, using only direct restorations. Such an approach is highly conservative, comfortable for the patient owing to the short treatment time, and cost-effective.
Figs. 2r & s
Five-year recall. The patient never did wear a night guard despite it being recommended. We can observe some additional tooth wear, mainly of an erosive nature (see, for instance, the cervical areas of the mandibular premolars). The restorations however show minimal wear or volume loss, apart from microfractures of a few margins (i.e., teeth II 46 and 47).
Europe Clinical Masters™ Program in Esthetic and Restorative Dentistry

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Online access to our library of Lectures & Clinical Videos
The Master Educational Group (MEG) is an educational center dedicated to esthetic dentistry with a heart-head-hands approach to clinical teaching and education. It offers innovative continuous education and interaction with dedicated and talented dentists, who share their passion with participants in exploring theory, innovations and technologies in a supportive environment. The center, in addition to educational and technological areas, offers operating rooms for multiple live sessions.

www.meg-educational.com

How to get there

The center is located seven kilometers from Milano Linate Airport. From Milano Linate Airport, you can take a connecting bus to Milano Centrale train station to the center of Milan. Then to get from Milan to Melegnano:

A chauffeur service is available via www.mydriver.com. Prices vary based on the car class, with an average of €54 for economy class, €61 for business class, €75 for a business van and €85 for first class.

Once at Milano Centrale train station, Line 3 on the subway will take you to Melegnano in about 20 minutes.

Where to stay

— In Melegnano

Ibis Styles Milano Melegnano is located 5.5 kilometers from the center and offers MEG special rates.

www.accorhotels.com | TripAdvisor Certificate of Excellence | 3-star

— In Milan

Hotel Milano Navigli is in the trendy Navigli neighborhood of historic Milan offering many clubs, cafés and vintage shops.

www.hotelmilanonavigli.it | TripAdvisor Certificate of Excellence | 3-star

Mercure Milano Solari is located between the city center and the canals, in the fashion and design quarter, where the showrooms of the biggest names in fashion and most innovative designers can be found.

www.mercure.com | TripAdvisor Certificate of Excellence | 4-star

NH Milano Palazzo Moscova is set in a grand neoclassical building, which was formerly Milan’s first train station.

www.nh-hotels.com | 4-star
Magna Pars Suites is a former perfume factory transformed into a stylish luxury hotel. www.magnapars-suitesmilano.it
TripAdvisor Certificate of Excellence 5-star

Where to eat

— In Melegnano
Melemangio, within walking distance of MEG, offers a fusion of the traditional cuisine of Parma and Milan, characterized by a modern interpretation and presentation, both satisfying and fun. www.melemangio-melegnano.it
Osteria del Portone, also within walking distance of MEG, serves typical regional dishes with a modern twist. www.osteriadelportone.com

— In Milan
Alice Ristorante is an elegant, warm and welcoming restaurant with its Mediterranean-influenced cuisine updated to suit current tastes. www.aliceristorante.it | 1 Michelin star
Armani/Ristorante offers a combination of style, elegance and sophistication featuring contemporary cuisine. milan.armanihotels.com | 1 Michelin star

Cracco serves traditional Milanese cuisine updated with a contemporary twist, enhanced by a superbly stocked wine cellar, boasting as many as 2,000 select vintages. www.ristorantecracco.it | 2 Michelin stars
Joia provides vegetarian haute cuisine. www.joia.it | 1 Michelin star
D’O, in Cornaredo, offers colorful, innovative cuisine based on authentic Italian ingredients. It is not located in the center of Milan, but well worth an out-of-town trip. www.cucinapop.do | 1 Michelin star

What to see and do

— In Melegnano
Melegnano is a town in the province of Milan, in the Lombardy region. The town lies 16 kilometers southeast of the city of Milan. For information on Melegnano and guided visits, inquire at Pro Loco (www.prolocomelegnano.it), located in the Medici Castle. It organizes cultural activities and local events, including exhibitions.

The Medici Castle is home to history, art and culture. It boasts two imposing medieval towers and evidence of Renaissance refinement, among them, sixteenth-century frescoes.
The Church of San Giovanni Battista, located in Piazza Risorgimento, has medieval origins, but was renovated with a façade of the early 1900s. It is home to many artworks, among them a painting by Bergognone.

— In Milan
Milan, the busy and fashionable Italian capital, is considered the international arbiter of taste in fashion and design. As one-time Imperial Roman capital, it combines a rich history with a strong sense of place.

Duomo Cathedral, a Gothic cathedral in the heart of Milan, took almost six centuries to complete and astounds with extravagant detail, including 135 spires and 3,400 statues.
La Scala is probably the world’s most famous opera house. It hosts classical concerts as well.
Museo del Novecento, located in the Palazzo dell’Arenario, accommodates Milan’s museum of twentieth-century art.
Castello Sforzesco houses several museums, among them, the Museum of Ancient Art, the Furniture Museum and the Picture Gallery.
Parco Sempione is a large park situated in the historic center of Milan.
INTERVIEW
with — Dr. Domenico Massironi

Q: Dr. Massironi, you have gained widespread recognition as a pioneer using the operating microscope in esthetic prosthetic dentistry since the late 1980s. What impact does the tool have in clinical practice today?
A: Modern dentistry is anchored in very conservative techniques, the least invasive possible. Preserving healthy dental tissue is now not only an objective but also a clinician’s duty. In this sense, the microscope offers a key tool for clear and precise vision, thus ensuring tissue integrity as far as possible and achieving a predictable and harmonious result. I always tell my students that the microscope has been a special teacher, whose constant and reliable presence has changed my way of seeing things.

Q: Minimally invasive treatment concepts have become incredibly important. What current surgical techniques stand out?
A: Surgery, especially in periodontics, demonstrates better healing and more conservative and predictable treatment of the soft tissue. Consider robotics used in abdominal and general surgery, the results in terms of reduced costs due to a shorter hospital stay and therapy without the invasive operations necessary in the past. This has become an area with reduced surgical invasiveness, owing to much improved visualization during surgery, which can only be positive for our clinical opportunities.

Q: The Master Educational Group (MEG) center, which you founded together with Dr. Carlo Ghezzi in 2013, is dedicated to higher education in esthetic dentistry and adopts a heart-head-hands approach. Could you please explain that further?
A: St Francis said, “He who works with his hands is a worker. He who works with his hands and head is a craftsman. He who works with his hands, his head and his heart is an artist.” Every time I meet a student searching, I try to convey this love for one’s job that comes from the heart. Talent lies in the heart. Hands follow it, as does the head. The MEG center was born from the desire to spread this heartfelt passion, which is made real through operating in excellence.

Q: What sets the MEG center apart from other institutions that focus on advanced training?
A: MEG is a unique center, established in order to teach and pass down knowledge gained over the years. Each workstation has a microscope and a workbench with a monitor for viewing live sessions. The simulators have been designed especially for MEG and allow for the use of the type of rotating instrument, from endodontics to implantation, with the possibility of using any model, even animal jaws, for surgery. MEG is the fruit of research into the search for perfectionism, through which to convey passion, enthusiasm and excellence.

The simulators, together with microscopes, monitors and video cameras, means it is possible to watch four simultaneous live transmissions and on the students’ screens visualize four previews from the big screen.

Q: What has influenced the work of clinicians?
A: The simulators, together with microscopes, monitors and video cameras, means it is possible to watch four simultaneous live transmissions and on the students’ screens visualize four previews from the big screen.

Q: In addition to the training center, the Massironi Study Club aims at fostering discussion and sharing knowledge among specialists. In times of social media and an omnipresent flood of information, how important is this kind of immediate exchange for dental professionals?
A: To distinguish, our blog, or social forum, was founded in 2009 and is linked to the osteocom implantology portal, which, thanks to tutors, permits us to have a site where we can exchange clinical cases, scientific articles and other information—a place to grow, with the respect and help of tutors and expert clinicians.

When the study club was established, we were a small group who wanted to share knowledge and experience. However, over time we created a nonprofit event based in Tirrenia, Italy, which has become an international meeting, reaching up to 250 participants last year for the tenth anniversary of the foundation of the study club.

Communicating scientific evidence in a world where everything tends toward simplification is an obligation. We have the duty to teach the scientific knowledge gained over time with honesty and above all professionalism, trying to avoid this superficiality and instant gratification, which carries the risk of burnout.

Q: Dental education differs from country to country and among specialties. Do you think there should be general guidelines concerning dental training?
A: A general guideline that knows no boundaries is heart, head and hands. I have travelled the world for many years, trying to teach in turn what I have learnt, and no matter where I go I have always found great homogeneity owing to an honest approach to the profession. Dental education does not differ in the world if the good of the patient is considered. Using the microscope with this in mind is extremely easy, even for those approaching it for the first time. I find that the secret of the training center is that of having a tutor demonstrating treatment live and correcting the student in his or her chosen course.

Q: Among other topics, you will focus on how new materials and simplified methods have changed the treatment workflow in everyday practice. From your personal experience, what has influenced the work of clinicians the most over the last several years?
A: Dentistry nowadays has benefited from the introduction of metal-free materials and digital techniques, which have definitely improved therapy and simplified laboratory procedures. One of the most fascinating aspects in this specialty has been the progress of adhesive techniques,
which have allowed us to treat esthetic cases while preserving healthy dental tissue. Innovative technology is ever more present and we will introduce this in the excellence that is our main objective.

Q: What are the main challenges in esthetic and restorative dentistry today?
A: The main challenge nowadays is finding the right balance regarding minimal invasiveness, often achieving an excellent esthetic result from limited preparation of the tooth. Esthetics is a direct consequence of maintaining the tooth’s health and function.

Q: Looking back on 25 years of experience, have you observed a shift in patients’ wishes and expectations regarding esthetic and restorative procedures?
A: Patients’ expectations have changed as a consequence of global access to information. The Internet has become a tool of knowledge available to all. We need to try, against this background, to offer clinical excellence based on honest and unspoken knowledge, offering our patients a special smile every time. A dentist who has unfortunately passed away since, once said, “The predictability of the result is tied to presuppositions, the presuppositions are created from knowledge, knowledge come from commitment and study, ability is an added value.” Well, guided by this insightful sequence, each case, simple or complex, is manageable in the excellence of esthetics, which makes the heart smile.

“Every time I meet a student searching, I try to convey this love for one’s job that comes from the heart”

— Dr. Domenico Massironi
**Objet Eden260VS Dental Advantage 3-D printer**

The Objet Eden260VS Dental Advantage (Stratasys) builds parts directly from digital files. It takes workflow automation a step further with soluble support material that dissolves easily from tiny cavities, overhangs and crevasses.

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**SoundLink Mini Bluetooth speaker II**

The SoundLink Mini II from Bose has been updated with a speakerphone, longer battery life for all-day listening, multiple connectivity for a phone and a tablet, as well as voice prompts for easy pairing, while still delivering the powerful, lifelike audio quality that made it the most famous little speaker in the world. With the built-in speakerphone, taking calls requires just the press of a button on the top of the speaker and the music resumes automatically once you’re finished.

© Bose Corp. | www.bose.com

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**Painting by Dr. Plotino**

Dr. Plotino recommends painting as a pastime and has himself produced several contemporary artworks, such as the one shown here.

© Dr. Gianluca Plotino

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**Apple**

All that is Apple.

© SGM/Shutterstock
Pilates
A system of low-impact exercises and stretches designed to improve physical strength, flexibility and posture.
© www.portalcotina.com.br

Axor Starck V
This single-lever basin mixer from Hansgrohe has a beautiful spout of crystal glass through which the powerful water vortex can be seen.
© Hansgrohe SE | www.axor-design.com

Skiing
Gliding through the snow in an awe-inspiring setting.
© Dr. Stavros Pelekanos

Inspiro composite system
Inspiro from Edelweiss DR offers simplicity and excellence in direct and indirect bonding using a simple shading and layering concept to address all natural shade variations, easily identified using an accurate bilaminar shade guide. Different shade-matching consistencies, flowable tints for characterizations and a truly universal homogeneous nanohybrid technology make this system suitable for all traditional clinical indications. It boasts superior mechanical properties, outstanding polishability and gloss retention for predictable and invisible restorations.
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A.S. Roma
For Drs. Plotino, Grande and Gambarini, our football fans.
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SMILE ANALYSIS
— Converting digital designs into the final smile, Part 2

“...anterior and posterior teeth have been analyzed and characterized for the last 50 years has not been effective, as some of those methods have correlated the shape and morphology of the teeth to the shape and proportion of the head.”

Introduction

The fabrication of restorations has entered a new technological age, moving from 2-D to 3-D. Restoration design—whether it is a framework, full-mouth rehabilitation or all-ceramic—now can be completed on computer. This article, the second in a two-part series (the first part of which appeared in the first issue of the Clinical Masters™ magazine), addresses tooth anatomy, morphology and the various laboratory applications for digital design.

Teeth are very difficult to recreate. The way anterior and posterior teeth have been analyzed and characterized for the last 50 years has not been effective, as some of those methods have correlated the shape and morphology of the teeth to the shape and proportion of the head. However, individuals with a square head do not necessarily have square teeth; rounder-faced individuals do not necessarily have round teeth, etc. There are no sex-specific or ethnic differences between teeth.

Tooth anatomy

All tooth anatomy is imparted in the front of the tooth, but what constitutes the front of the tooth has to be clearly identified and defined. This is predicated on understanding where the contacts and embrasures should be positioned relative to proper tooth anatomy. Embrasures must be properly angled, as well as opened mesially or distally, depending upon the anatomical buildup that is required. Once
that has been identified, primary anatomy can be established, followed by secondary anatomy. It is important to note that characteristics of secondary anatomy, such as texture and luster, can change the perception of the tooth shape and value. Restorations that are smooth appear translucent and lower in value. Rougher restorations, because of the manner in which light reflects off the front, appear more brilliant but less translucent, despite possessing the same translucency. The various kinds of textures—broad, horizontal striations; narrow, horizontal striations; vertical striations; and a dimpled texture over the front of the tooth—create various visual characteristics.

**Digital dentistry**

Although basic dentistry has not changed a great deal in the past 20 years, innovative materials and equipment are continually enhancing the dental field. Owing to its state-of-the-art applications, allowing creation of strong and esthetic ceramic restorations in a single appointment utilizing computer software, CAD/CAM technology has become synonymous with digital dentistry. CAD/CAM is an innovative tool for creating a restoration designed on computer. Digital dentistry, however, encompasses communication, high- and low-resolution data, 3-D photography, and computer programs that provide dentists with the ability to create digital restorations and virtual patients through the collection of data and the utilization of various software programs. The compilation of conventional data for planning and treating patients, including demographic data, clinical measurements, observation, clinical analysis, thermal data, and color data, has been expanded to include digital data, intra-oral photographs, scan data, cone beam computed tomography data, and digital radiographs for digital planning and restorative treatment.

Conventionally, a digital restoration was a zirconia coping built up with modifiers, dentins, and enamels, sculpted by hand, ground down where necessary, baked, then stained and glazed. Today, a dentinal structure can be milled from a lithium disilicate block and enamel added, or from a block of ceramic prelayered with gingival dentin and incisal materials and milled using CAD/CAM technology, with no discernible differences evident among the three restorations. The only difference is time. The first is labor-intensive, the second less so and, as expected, the machine-milled restoration is the quickest and easiest of all to produce.

**CAD/CAM**

The attainment of perfection in the duplication of natural dentition is the ultimate goal of contemporary esthetic dentistry. Understanding the complex relationship between tooth form and function, and how these relate and combine to create the esthetics of natural dentition is the basis of study for achieving predictable success in oral reconstruction. As patients become more educated about the advances of modern dentistry (as a result of television makeover shows and professional and over-the-counter whitening systems), their motivation and desire for natural-looking, esthetic restorative dentistry is increasing at a dramatic rate. Dentists and technicians are now fulfilling these patient demands, but still use dental laboratories...
and restorative techniques that do not always offer predictable efficiency and quality.

Based upon technology adopted from the aerospace, the automotive and even the watch-making industries, CAD/CAM is becoming widely accepted owing to its increased speed, accuracy and efficiency. Today’s CAD/CAM systems are being used to design and manufacture metal, alumina and zirconia frameworks, as well as all-ceramic full-contour crowns, inlays and veneers that are stronger, fit better and are more esthetic than restorations fabricated using traditional methods. As dentistry evolves in the digital world, the successful incorporation of computerization and new acquisition and manufacturing technologies will continue to provide more efficient methods of restoration fabrication and communication, while retaining the individual creativity and artistry of the skilled dentist and technician. The utilization of these new technologies—along with the evolution from hand design to digital design, with the addition of the latest developments in intra-oral laser scanning, materials, and computer milling and printing technology—will only enhance the close cooperation and working relationship of the dentist–laboratory team.

More than 20 different CAD/CAM systems have been released as solutions for restorative dentistry. The introduction of digital laboratory laser-scanning technology, along with its accompanying software, has allowed the dental laboratory to create a digital dental environment to present an accurate 3-D virtual model that automatically takes into consideration the occlusal effect of the opposing and adjacent dentition. With the model, the laboratory has the ability to design 32 individual full-contour anatomically correct teeth at the same time. These systems essentially take a complex occlusal scheme and its parameters, condense the information and display it in an intuitive format that allows dental professionals with basic knowledge of dental anatomy and occlusion to make modifications to the design, and then send it to the automated milling or printing unit. For the dental laboratory profession, the introduction of digital technology has effectively automated—and even eliminated—some of the more mechanical and labor-intensive procedures (waxing, investing, burnout, casting and/or pressing) involved in the conventional fabrication of a dental restoration, giving the dentist and technician the ability to create functional dental restorations with a consistent, precise method.

“As dentistry evolves in the digital world, the successful incorporation of computerization and new acquisition and manufacturing technologies will continue to provide more efficient methods of restoration fabrication and communication.”

**Digital case**

The patient presented with a desire to have his anterior teeth restored and to have a more esthetic shape and color, while retaining the natural color nuances of his posterior teeth (Fig. 4). A comprehensive examination was performed to evaluate the patient’s periodontal and occlusal or functional needs, as well as his overall oral health. Despite extreme tooth discoloration, the basic tooth structure was found to be satisfactory for restoration. After esthetic and functional evaluation, it was deemed necessary to use full-coverage preparations and restorations to restore both esthetics and anterior guidance and function. As with any restorative process that will change tooth shape, position and function, a diagnostic workup (wax-up) was completed. After the patient, dentist and technician had all agreed to the proposed changes, the clinical preparations were completed, and a copy of the wax-up was created for the temporary PMMA restorations for the intra-oral evaluation. Once the provisional restorations had been approved, it became the technician’s responsibility to copy the temporary restorations in fabricating the final IPS e.max lithium disilicate (Ivoclar Vivadent) restorations (Figs. 5–23).
Fig. 5  Digital design for the diagnostic wax-up.

Fig. 6  Milled diagnostic wax-up.

Fig. 7  Completed digital diagnostic wax-up.

Fig. 8  Maxillary full-coverage crown preparations.

Fig. 9  Mandibular full-coverage crown preparations.

Fig. 10  Digital design for laboratory-milled PMMA provisional restorations.

Fig. 11  Milled PMMA provisional restorations, with light-cured stains and glaze applied.

Fig. 12  Intra-oral view of seated provisional restorations.

Fig. 13  Digital design for final milled maxillary all-ceramic IPS e.max CAD restorations.

Fig. 14  Digital design for final milled mandibular all-ceramic IPS e.max CAD restorations.

Fig. 15  Digital articulator with restorations, to check functional movements.

Fig. 16  Milled maxillary blue-stage IPS e.max CAD restorations.

Fig. 17  Milled mandibular blue-stage IPS e.max CAD restorations.

Fig. 18  IPS e.max CAD restorations after the crystallization process.

Fig. 19  Stain and glaze of IPS e.max CAD restorations.
Conclusion

This article has provided an overview of the possibilities of digital smile design, using computer design software, for the design of the milled diagnostic wax-up, the milled provisional restorations, and the final milled ceramic restorations.

CAD/CAM technology should not be regarded as mere machinery to fabricate full-contour ceramic restorations or frameworks; digital dentistry represents a new way to diagnose, plan treatment, and create functional, esthetic restorations for patients in a more productive and efficient manner. CAD/CAM dentistry will only further enhance the dentist–assistant–technician relationship as we move together into this new era of patient care.

Automation has been slow in coming to dentistry and although new equipment has been introduced to make our work easier, we still create complex dental prostheses using old techniques. Even though the lost-wax technique is still a tried-and-true method of fabrication, there will come a day in the near future when all frameworks and full anatomical crowns will be designed on computer. Only then will we truly realize the wonder and power of dental CAD/CAM technology that was introduced so long ago.

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Competing interests

Mr. Culp receives an honorarium from Ivoclar Vivadent. Prof. McLaren and Dr. Swann declare that they have no competing interests regarding this article.

“Once the provisional restorations had been approved, it became the technician’s responsibility to copy the temporary restorations in fabricating the final ceramic restorations.”

Fig. 20
Post-op image of cemented maxillary all-ceramic restorations.

Fig. 21
Post-op image of cemented mandibular all-ceramic restorations.

Figs. 22 & 23
Final view of digitally designed and milled IPS e.max CAD anterior restorations, showing excellent fit, form and natural-looking esthetics.

Editorial note: A list of references is available from the publisher.

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INTERVIEW
with — Dr. Stavros Pelekanos

Q: Dr. Pelekanos, what is the role of esthetics in dental implantology today?
A: Implantology in the 1980s and 1990s was bone-driven. The Albrektsson criteria for a successful implantation back in 1986 did not even refer to esthetics and were followed for many years to come. Nowadays, prosthodontists start the treatment and perform backwards planning, always keeping in mind the correct positioning of the tooth or teeth to be replaced.

Q: Patients’ expectations regarding esthetic results are growing with the emergence of new technologies and materials. However, have these innovations truly arrived in every dental office?
A: Well, in continuation of my response to your first question, there are two major problems that the dental community has been facing in recent years, incorrect implant positioning and periimplantitis both being difficult to resolve. As patients become more aware of these complications, they expect and demand more esthetic and predictable results. New technologies such as high-resolution CBCT, CAD/CAM abutment manufacture, abutments produced using new zirconia technologies, and digital planning are already widely in use in everyday dentistry, minimizing risks, as well as enhancing esthetics and treatment workflow.

Q: Have digital solutions changed the way dental restorations and full-mouth rehabilitations in particular have been performed over the past several years?
A: Digital planning, intra-oral digital impressions and CAD/CAM technologies have really changed implantology today. First of all, preoperative planning is a helpful tool for ensuring correct implant placement, for both novice and experienced surgeons. Furthermore, more conservative (sometimes flapless) surgical approaches result in much less postoperative swelling, facilitating greater patient acceptance. The digital workflow in prosthodontics facilitates milled abutment constructions or even same-day teeth when immediate loading or provisionalization is chosen in the treatment planning. CAD/CAM laboratory procedures reduce human error, providing more robust and accurate frameworks and final reconstructions.

Q: In your experience, what is the best way to achieve a natural-looking implant crown?
A: Irrespective of the digital revolution, the hand skills of a talented dental technician are indispensable, especially in the case of a single implant crown next to natural teeth. Machines will never replace the human hand, as individual perception of every case, the knowledge of biology and anatomy are of the greatest importance. The factors that determine the success and natural appearance of an implant crown are accurate implant positioning, meticulous bone and soft-tissue handling, and a skilled dental technician.

Q: The number of implants placed worldwide is expected to double over the next five to six years. Consequently, education efforts have to double too in order to ensure that dentists are adequately trained in implant placement. Do you agree with this statement?
A: Of course; however, and I say this although I am a faculty member of the School of Dentistry of the University of Athens, which provides education at the highest level, students are still unfortunately not adequately trained in implants. Postgraduate studies in a university environment or very well-organized implant master programs are necessary for a dentist to be able to place or restore implants.

Q: We have seen quite a few different concepts emerging over the last several years in esthetic dentistry, such as bio-emulation and smile design. Which concepts will have the most impact in the future and change the way esthetic dentistry is performed?
A: Well, as a prosthodontist, I have to say there is nothing new in these concepts. Basic esthetic rules are to be applied in every prosthodontic case, such as tooth positioning, proportion, occlusion, color and design. However, digital technology is a very helpful tool, especially for the novice dentist, for implementing these rules and simplifying the treatment workflow. The same applies to bio-emulation. Biological concepts, improved materials and techniques are always there to simplify clinical dentistry and reduce potential errors and complications.

Q: What is the position of esthetic dentistry in the development of dental specialties in your opinion?
A: Esthetic dentistry is not a recognized specialty generally, falling mainly under prosthodontics.

“As patients become more aware of these complications, they expect and demand more esthetic and predictable results.”

I do not think esthetic dentistry should be a stand-alone specialty. Being trained in a periodontic-prosthodontic environment (University of Freiburg, Germany, under Prof. J.R. Strub), I believe that a modern restorative dentist should be adequately trained in more than one main area. Periodontics, prosthodontics and restorative dentistry all constitute what is considered esthetic dentistry.
“Machines will never replace the human hand, as individual perception of every case, the knowledge of biology and anatomy are of the greatest importance.”
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MATCHING GUTTA-PERCHA CONES — to NiTi rotary instrument preparations

Introduction

With the widespread use of rotary nickel-titanium (NiTi) instruments, matched-taper gutta-percha (GP) cones of greater tapers were developed to make root canal obturation techniques easier and more predictable, and possibly to improve the quality of 3-D fillings. Nowadays, many manufacturers produce matched-taper GP cones intended for use with a specific instrumentation technique. Consequently, the single-cone technique has regained popularity, since a single matched-taper cone can produce a satisfactory 3-D fill, and warm vertical techniques benefit from the use of a matched-taper master cone by a reduced risk of voids inside the filled endodontic space.

However, the larger number of and variability in design and dimensions of commercially available NiTi instruments and GP cones of greater tapers can easily create confusion among practitioners, especially if using instruments and cones of different brands. If the GP cones selected do not precisely match with the NiTi instruments used, the whole concept fails and in many cases the GP cones do not reach the desired working length or do not precisely fill the apical preparation.

In order to understand how matched-taper GP cones should work, it is important that clinicians be aware of the differences in size, taper, design and manufacturing process of these products. Even if these factors are usually taken into account when a manufacturer produces matched-taper GP cones to be used with a specific instrumentation technique, the goal of the present paper is to discuss all of these variables and give clinicians a better understanding of the possible clinical problems they may encounter in cone fitting and practical solutions to these.

Size, tolerance and manufacture of GP cones

Conventionally, GP cones are hand rolled, a manufacturing process that is neither very precise nor consistent. Therefore, according to ISO standards, the tolerance allowed for GP cones is 0.05 mm, much larger than the tolerance allowed for endodontic instruments produced by grinding or twisting (0.02 mm). This has always been a problem in endodontics and it explains why correct fitting of the master cones in all techniques (single-cone, lateral condensation, warm vertical condensation, continuous wave of obturation) has always been described as a fundamental step in the procedure.

With the conventional ISO 0.02-tapered cones, the problem was mainly related to the lack of precision of the tip of the GP cones. Therefore, GP tips needed to be manually adjusted to fit the apical preparation with good retention (tug-back) in order to avoid underfilling or overextension of cones through the apical foramen. The same procedure was needed for non-
standardized GP cones with feathered tips. For this reason, specific calipers and instruments to cut GP cones precisely were developed.

With the introduction of GP cones of greater tapers, a problem related also to the taper arose. These new GP cones can be grouped into two categories: uniform and nonuniform taper. The former cones are usually marketed as 0.04- or 0.06-tapered cones, while the latter are usually marketed in association with a brand name related to a specific instrumentation technique (e.g., ProTaper cones, DENTSPLY; and TF Adaptive [TFA] cones, Kerr). Development of these cones was necessary, since nowadays more NiTi rotary instruments have a nonuniform taper (e.g., ProTaper cones, DENTSPLY; and TF Adaptive [TFA] cones, Kerr). Development of these cones was necessary, since nowadays more NiTi rotary instruments have a nonuniform taper (e.g., ProTaper cones, DENTSPLY; and TF Adaptive [TFA] cones, Kerr). Development of these cones was necessary, since nowadays more NiTi rotary instruments have a nonuniform taper (e.g., ProTaper cones, DENTSPLY; and TF Adaptive [TFA] cones, Kerr).

**Fig. 1**

Comparison of instruments and cones with uniform and nonuniform tapers.

**Tip sizes and tapers of NiTi instruments**

While some instruments have a nonuniform taper, the majority of endodontic NiTi rotary instruments have a uniform taper, and the associated techniques are intended to create at least a 0.04- or 0.06-tapered preparation. For this reason, GP cones of greater tapers are usually sold in 0.04 and 0.06 tapers. However, NiTi instruments with the same nominal size and taper may not have the same dimensions and consequently not create an identical root canal preparation, since the length of the working part may be different (Fig. 1). For example, in a 25.06 K3XF instrument (Kerr; or other instruments, including Revo-S, MICRO-MEGA; ProFile, DENTSPLY; and Race, FKG Dentaire), the working part is 16 mm, while in a 25.06 TF instrument, it is 10 mm. Even if the taper and tip sizes are the same, a 25.06 K3XF instrument will enlarge the root canal to 1.21 mm. This calculation can be made as follows: 0.06 mm increase for each millimeter, multiplied for 16 mm = 0.96 mm + 0.25 mm tip size = 1.21 mm. In contrast, a 25.06 TF instrument (a file with a reduced working part) will enlarge the canal to a lesser extent: 0.85 mm (0.06 mm × 10 mm = 0.60 mm + 0.25 mm tip size = 0.85 mm).

Similar differences can be found between any NiTi instrument with a conventional 16 mm working part compared with any other instrument with a reduced working part. NiTi instruments with a shorter working part are widely used because a shorter working part creates less stress during instrumentation by reducing taper lock and torsional stress in the coronal part, the largest section of the instrument. With a lower operative torque, efficiency and safety are more easily improved.
the same reason, some instruments have a nonuniform taper, which usually is smaller in the coronal part, in order to gain more torsional strength in the apical part and more flexibility in the coronal part. Nevertheless, instruments with shorter working parts or nonuniform tapers need GP cones with the same design and dimensions in order to allow a good match between the prepared canals and the obturating materials.

Matching instruments with nonuniform tapers with GP tapered cones

The same differences in dimensions previously described between instruments (e.g., K3XF compared with TF) can be found between 0.04-/0.06-tapered GP cones and cones with nonuniform tapers (e.g., ProTaper and TFA cones). The first few millimeters are usually similar, but in the middle or coronal part, the GP cones might be much wider. Therefore, if a 0.04-/0.06-tapered GP cone is used in a root canal prepared with nonuniform-taper instruments, the GP cone will probably not go to working length, because of the greater dimensions of the cone in the middle or coronal part. This could be considered GP taper lock.

This is a different problem to that experienced by dentists in the past, which was mainly related to cone fitting in the apical part, and consequently requires a different approach. Choosing a cone with a smaller tip size may not solve the problem, while choosing a smaller-taper cone may significantly increase the risk of iatrogenic errors such as underfilling and overextension of the cone through the apical foramen, because the tug-back in the coronal part does not allow for correct fitting of the apical part of the cone.

Therefore, the best and easiest solution is to choose brand-associated GP cones that precisely fit the root canal preparation achieved by the specific NiTi instruments and allow for ideal 3-D filling and good apical tug-back. However, with the K3XF system, clinicians could use both types of cones (i.e., the 0.04–0.06 cones or TF/TFA cones) because they will both fit the root canal preparation in the apical and middle thirds well, whereas tug-back and 3-D matching are more critical.

More clinical hints

Thus far, dimensions and sizes have been discussed to help clinicians understand the difficulties in matching instruments and cones. However, there are also clinical ways to seek to solve problems encountered during these procedures. The following advice may be useful for both instruments with nonuniform tapers and many instrumentation techniques.

— Create greater coronal flaring

If a GP cone does not perfectly match the root canal preparation and thus does not reach the working length, one possible solution is to increase the coronal flaring by brushing with the last instrument used. By doing so, the NiTi instrument will increase the dimensions of the prepared canal in the coronal part, solving the problem of GP taper lock.

— Ensure correct apical fit

Clinicians may experience two different clinical problems in the apical fit: the need for a better apical tug-back, which may require slightly cutting the tip of the master cone, and the fit related to the amount of canal transportation. The first situation may occur when, owing to the different dimensional tolerance, a GP cone is slightly smaller than the nominal size, increasing the risk of overfilling during obturation. In such a case, the advice is to increase the dimensions of the master cone slightly by cutting 0.5–1 mm off the tip, or ideally to recalibrate the master cone precisely using a tip-snip device. This can also occur if a canal is slightly overinstrumented (e.g., owing to an error in determination of the working length or in the position of the rubber stop on the file). In such a situation, the apical constriction would have been modified and the cone fit would have to compensate for the error by increasing the tip size of the GP master cone.

Some NiTi instruments (HyFlex; TFA; TRUShape, DENTSPLY; NEONITI, NEOLIX; etc.) are significantly more flexible than the majority of competing NiTi rotary instruments. As a consequence, they tend to follow and maintain the original trajectory of the root canals more precisely, minimizing canal transportation. Canal transportation frequently occurs when a rigid file is inserted into a curvature and tends to straighten it by cutting more in the inner part of the curvature coronally and in the outer part apically. However, this error, which can affect the quality of debridement, makes insertion of master GP cones easier, especially when complex, double or triple curvatures are present. For this reason, clinicians using such flexible NiTi instruments may experience slightly more difficult insertion of the master GP cone to the working length. If this problem occurs, once again slightly increasing flaring by circumferential filing can help.

Conclusion

It may be concluded that clinicians who use instruments with nonuniform tapers or with reduced working parts should preferably use brand-associated GP cones that perfectly match with the prepared canals. By doing so, fitting the master GP cone becomes much easier and more predictable. In the very few cases in which problems still arise, the clinical hints provided may help practitioners to understand the problem and find a proper solution.
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INTERVIEW
with — Prof. Fabio Gorni

Q: You have been a practicing dentist for about 30 years now, with a specialization in endodontics and surgical endodontics. In your opinion, what has been the most important development in the field over the past three decades?
A: Endodontics is probably the dental specialty in which the most significant technological innovations have been introduced. The major innovations have encompassed instruments, materials and equipment. In terms of the improvement in instruments, rotary nickel-titanium (NiTi) files are the greatest innovation.

Regarding materials, bioceramic cements have to be taken into consideration, since they represent an enormous opportunity for the clinician. They can be used differently and have several applications, in particular treatment of severely compromised teeth. Nevertheless, we have to remember that the daily employment of magnification is one of the most important factors to be considered.

Q: Developments in technology and materials continue to influence the practice of endodontics. How has the way root canal treatment as practiced by endodontists changed over the years?
A: Certainly, these innovations have allowed therapeutic advances, for both patients and the dentist. In fact, it is possible to perform a faster and more predictable therapy. It is certainly possible to preserve dental tissue owing to minimally invasive shaping of the root canals, but it can still ensure proper cleaning and, last but not least, it is possible to save teeth that just a few years ago would have been extracted.

Q: Recently, a study conducted at the University of California, Los Angeles (UCLA) demonstrated that using nanodiamonds to fortify gutta-percha could significantly improve outcomes in patients. Do you think this could be the obturation material of the future?
A: First of all, I would like to congratulate Prof. Dean Ho and No-Hee Park and their team at the UCLA School of Dentistry for the high quality and the innovation of their recent article. Without any doubt, we can say that gutta-percha has been the preferred material for root canal filling, even with the great necessity to reduce periapical infection and to improve the material stability.

In this research, the authors found a successful method by which to improve the manageability of gutta-percha, obtaining an apical seal similar to the conventional one. In addition, it is important to underline the relevance of the data relative to amoxicillin-enriched gutta-percha. The in vitro study proved that drug-reinforced nanodiamonds combined with gutta-percha effectively prevented bacterial growth. However, this innovation needs to be proven in a clinical study, with appropriate records and the necessary follow-up.

In my opinion, bioceramic materials could bring about even greater advances in endodontics owing to their versatility.

Q: In the U.S., the majority of root canal treatment is performed by general dentists. Have these dentists adopted newer technologies, such as digital radiography and NiTi rotary instrumentation?
A: The innovation brought about by NiTi rotary instruments has been substantial and has changed daily practice both for the endodontist and for the general practitioner. In fact, it offers the possibility of obtaining a qualitatively good therapy in a short time. Digital radiography is not as relevant as NiTi rotary instruments are for achieving a successful therapy. However, 3-D radiography had a considerably positive impact on diagnostic methods. This method is based on a low radiation dose and increases the ability to make an accurate diagnosis, which guarantees a great result for the patient and a notable reduction of time for the operator.

Q: Could you tell us a little about Style Italiano Endodontics, your role within that community and why it is important to you?
A: Style Italiano, which has more than 100,000 followers, is the largest dental community in the world. It started as a restorative sharing group and the idea of

Style Italiano Endodontics was born from this body, less than six months ago. Style Italiano Endodontics is about to reach 35,000 followers.

The purpose is to give to modern dentists clear and accurate guidance and practical suggestions to apply during their daily treatment of patients. The three keywords that describe the philosophy of the group are “feasible,” “teachable” and “repeatable.”

Based on this idea, Style Italiano uses Facebook as a way to communicate all over the world and to share clinical cases with a large community of operators, so it becomes easier to make and to receive criticism and commentary.

This high visibility allows a dentist to share his or her work with a large number of people and compare it with many other ideas, so it can be regarded as an opportunity to learn and improve new techniques and share new and simple protocols. The main motto of the Style Italiano team is “you can do what we do.”

Q: What role do you think courses such as the Tribune CME Clinical Masters™ Program play in promoting the skills and expertise of endodontists and general dentists?
A: I think that, nowadays, dentistry needs to be based on techniques recognized and accepted by the scientific community worldwide.

The Tribune CME Clinical Masters™ Programs are held in the world’s largest cities, like San Francisco, Rio de Janeiro, Milan and Dubai, and they are led by some of the most prominent experts in dentistry. These courses offer “lifelong learning concepts for an ever-changing industry,” access to high-quality training institutes from anywhere, the possibility of practical training in the faculty’s own environment, and live mentoring sessions with experts and peers.

I believe that never before have such a large number of experts in various dental specialties been brought together to offer a program universally recognized as a certificate of excellence.

“It is possible to save teeth that just a few years ago would have been extracted.”
Location
Florence, the capital of Tuscany is a cultural, artistic and architectural gem. One of its most influential families, the Medicis, not only sponsored the arts, but was of great importance owing to their thriving commercial activity and subsequent political influence. Florence is considered to be the birthplace of the Italian Renaissance, home to creative geniuses and scientific masterminds, who left their legacies in the city’s many museums and art galleries. Florence’s economic strength fostered the growth of mercantile guilds and attracted an influx of immigrants. Today, the city is known for its dedication to its artistic and historic patrimony and is regarded as one of the top destinations in the world.

www.endocastellucci.com

How to get there
The city center is located 8 kilometers from Peretola airport. It can be reached in about 15 minutes by taxi and about 20 minutes by bus on the Vola in Bus shuttle (run by Busitalia Sita Nord), which operates between the airport and the central railway station of Santa Maria Novella.

www.fsbusitalia.it

Where to stay
The following hotels are all located within two kilometers of Dr. Arnaldo Castellucci Dental Studio and the town center:

Hotel Regency, situated in a quiet, residential area, this boutique hotel is the result of careful restoration of an original Florentine villa.

www.regency-hotel.com | TripAdvisor Certificate of Excellence | 5-star

Hotel Monna Lisa is housed in a fifteenth-century renaissance palace and offers old-world rooms surrounded by peaceful, landscaped gardens.

www.monnalisa.it | TripAdvisor Certificate of Excellence | 4-star

Hotel Santa Maria Novella, set in a picturesque square, offers well-appointed rooms and its rooftop terrace overlooks the Basilica of Santa Maria Novella.

www.hotelsantamarianovella.it | TripAdvisor Certificate of Excellence | 4-star

Hotel Plaza Lucchesi, overlooking the Arno River, is a very elegant hotel offering amazing views of the landscape and the city from its rooftop terrace, where you can enjoy a drink or a swim.

www.hotelpiazzaLucchesi.it | TripAdvisor Certificate of Excellence | 4-star

Hotel Villa Liana offers accommodation in a nineteenth-century villa, a former British consulate, boasting the original ceiling frescos and set in an English-style garden.

www.hotelliana.com | TripAdvisor Certificate of Excellence | 3-star

— Dr. Arnaldo Castellucci, M.D., D.D.S.

graduated in medicine at the University of Florence in 1973 and specialized in dentistry at the same university in 1977. From 1978 to 1980, he attended continuing education courses on endodontics at Boston University School of Graduate Dentistry (now the Boston University Henry M. Goldman School of Dental Medicine) in the U.S. As well as running a practice limited to endodontics in Florence, he is Professor of Endodontics at the University of Cagliari dental school in Italy and Professor of Surgical Endodontics at the University of Naples Federico II oral surgery department, also in Italy.

Dr. Castellucci is the founder and President of the Warm Gutta-Percha Study Club and of the Micro-Endodontics Training Center in Florence, where he teaches and gives hands-on courses. He is past President of the Italian Endodontic Society, past President of the International Federation of Endodontic Associations, as well as an active member of the European Society of Endodontontology, the American Association of Endodontists and the Italian Society of Restorative Dentistry.

An international lecturer, Dr. Castellucci has published more than 60 articles and is the author of the book Endodontics. He is the past editor of the Giornale Italiano di Endodonzia (Italian journal of endodontics) and L’ Informatore Endodontico (endodontic informer) and is the Editor-in-Chief of Endo Tribune Italy.

With over 35 years of practice, Dr. Arnaldo Castellucci is an internationally recognized specialist in the field of endodontics. Owing to his passion for teaching and experimenting, passed on to him by Prof. Herbert Schilder, he established a training center at his practice, where he passes on all the knowledge he has gained over the years to students and colleagues in search of a greater degree of specialization with today’s modern technologies. At the center, there is a classroom with ten workstations equipped with an operating microscope and the necessary instruments to perform the procedures taught in the best way possible on mannequins and plastic models.

Dr. Castellucci offers his theoretical and practical courses throughout the year, ensuring flexibility for anyone not able to participate during certain periods of the year.
Palazzo Vecchio, located next to the Uffizi Gallery, is one of the most famous symbols of Florence. From its tower, you can enjoy a wonderful view of the city.

The Cappella Brancacci is a chapel in the Basilica di Santa Maria del Carmine with magnificent frescoes painted by Masolino da Panicale, Masaccio and Filippino Lippi.

Corridoio Vasariano, built to allow the Medici to move between their two palaces, is a covered passageway connecting Palazzo Vecchio with the Palazzo Pitti. The Museo di Palazzo Davanzati is housed in a fourteenth-century palace, once home to the wealthy Davanzati family, and its present arrangement aims at reconstructing the setting of an old Florentine home.

The Museo dell’Opera del Duomo contains many of the original works of art created for the Cattedrale di Santa Maria del Fiore, including masterpieces by Ghiberti, Donatello, Luca della Robbia, Antonio Pollaiolo, Verrocchio and Michelangelo.

The Museo di San Marco, occupying a vast area of the Dominican convent of San Marco, founded in 1436, showcases the work of Fra Angelico, who frescoed extensive parts of the convent.

For more information visit: www.firenzeturismo.it

Where to eat

Winter garden by Caino, in the elegant setting of a sophisticated winter garden, is a collaboration between Chef Michele Griglio and Chef Valeria Piccini that sets new heights for a refined restaurant experience.

www.restaurantbycainoflorence.com
1 Michelin star

Panini Toscani is an Italian delicatessen serving paninis and a selection of cheeses and cold meats (no dinner).

The following trattoria and ristorante serve typical Tuscan cuisine:

Trattoria Coco Lezzone—Dr. Castellucci’s favorite
www.cocolezzone.it

Perseus—the house specialty is Florentine steak.
www.casatrattoria.com

Trattoria 13 Gobbi
www.casatrattoria.com

Trattoria l’l Parione
www.parione.net

Il Cibrèo offers fine, inventive cuisine inspired by traditional dishes.
www.edizioniteatrodelsalecibreofirenze.it
NEW TECHNOLOGIES
— to improve root canal disinfection

Dr. Nicola M. Grande & Prof. Gianluca Gambarini, Italy

Introduction
The major causative role of micro-organisms in the pathogenesis of pulp and periapical diseases has clearly been demonstrated. The main aim of endodontic therapy is to disinfect the entire root canal system, which requires the elimination of micro-organisms and microbial components and the prevention of its reinfection during and after treatment. This goal is achieved through chemomechanical debridement, for which mechanical systems are used with irrigating solutions.

Standard endodontic irrigation protocol
— Sodium hypochlorite
Sodium hypochlorite (NaOCl) is the main endodontic irrigant used, owing to its antibacterial properties and its ability to dissolve organic tissue. NaOCl is used during the instrumentation phase to increase its time of action within the canal as much as possible without it being chemically altered by the presence of other substances. The effectiveness of this irrigant has been shown to depend on its concentration, temperature, pH solution and storage conditions. Heated solutions (45–60 °C) and higher concentrations (5–6%) have greater tissue-dissolving properties. However, the greater the concentration, the more severe the potential reaction if some of the irrigant is inadvertently forced into the periapical tissue. In order to reduce this risk, the use of specially designed endodontic needles and an injection technique without pressure is recommended.

— EDTA
The main disadvantage of NaOCl is its inability to remove the smear layer. For this reason, combination of NaOCl with EDTA (ethylenediaminetetraacetic) is recommended. EDTA has the ability to decompose the inorganic component of intracanal debris and is generally used in a percentage equal to 17%. EDTA appears to reduce the antibacterial and solvent activity of NaOCl; thus, these two liquids should not be present in the canal at the same time. For this reason, during mechanical preparation, abundant and frequent rinsing with NaOCl is performed, while the EDTA is used for 2 min at the end of the preparation phase to remove the inorganic debris and the smear layer from the canal walls completely.

— Ultrasonic activation of NaOCl
The use of ultrasound during and at the end of the root canal preparation phase is an indispensable step in improving endodontic disinfection. The range of frequencies used in the ultrasonic unit is between 25 and 40 kHz. The effectiveness of ultrasound in irrigation is determined by its ability to produce cavitation and acoustic streaming. Cavitation is minimized and limited to the tip of the instrument used, while the effect of acoustic streaming is more significant. Ultrasound creates bubbles of positive and negative pressure in the molecules of the liquid with which it comes into contact. The bubbles become unstable, collapse and cause an implosion similar to a vacuum decompression. Exploding and imploding...
they release impact energy that is responsible for the detergent effect. It has been demonstrated that ultrasonic activation of NaOCl dramatically enhances its effectiveness in cleaning the root canal space, as ultrasonic activation greatly increases the flow of liquid and improves both the solvent and antibacterial capacities and the removal effect of organic and inorganic debris from the root canal walls.

Ultrasonic activation of NaOCl of 30–60 s for each canal, with three cycles of 10–20 s (always using new irrigant), appears to be sufficient time to obtain clean canals at the end of the preparation phase (Figs. 1 & 2). Ultrasound appears to be less effective in enhancing the activity of EDTA, although it may contribute to better removal of the smear layer. The accumulation of debris produced by mechanical instrumentation in inaccessible areas is preventable by using ultrasonic activation of NaOCl even during the preparation phase. The use of a system of ultrasonic continuous irrigation might therefore be advantageous. It involves the use of a needle activated by ultrasound. With this method, the irrigant is released into the canal and is activated by the action of the ultrasonic needle simultaneously.

— Chlorhexidine

A final flush with 2% chlorhexidine (CHX) after the use of NaOCl (to dissolve the organic component) and EDTA (to eliminate the smear layer) has been proposed to ensure good results in cases of persistent infection, owing to its broad spectrum of action and its property of substantivity. However, the use of CHX is hindered by the interaction between NaOCl and CHX, which tends to create products that may discolor the tooth and precipitates that may be potentially mutagenic. For this reason, CHX should not be used in conjunction with or immediately after NaOCl. This interaction can be prevented or minimized by an intermediate wash with absolute alcohol, saline or distilled water.

Activation systems

Mechanical instrumentation alone can reduce the number of micro-organisms present within the root canal system even without the use of irrigants and intracanal dressings, but it is not able to ensure an effective and complete cleaning. Irrigating solutions without the aid of mechanical preparation are not able to reduce the intracanal bacterial infection significantly. For these reasons, today research is oriented toward the study of systems that can improve root canal disinfection through mechanical activation of endodontic irrigants, and in particular NaOCl. Multiple agitation techniques and systems for irrigants have been used over time, demonstrating more or less positive results.

— Manual agitation techniques

The simplest technique of mechanical activation of irrigants is manual agitation, which can be performed with different systems. The easiest way to achieve this effect is to move vertically an endodontic file that is passive in the canal. The use of the file facilitates the penetration of the irrigant, leads to a more effective delivery of irrigant to the untouched canal surfaces and reduces the presence of air bubbles in the canal space, but does not improve the final cleaning. Another similar technique moves vertically a gutta-percha cone to working length with the canal...
filled with irrigant. Even this method, however, has not been found to improve the intracanal cleaning. For this purpose, in each case, well-fitting gutta-percha cones (increased taper) were more effective than cones with the standard taper (0.02). The use of endodontic brushes and of particular needles for endodontic irrigation with bristles on their surface is another technique suggested in order to move the irrigant more effectively within the canals. These systems have been shown to be valid in the removal of the smear layer from root canal walls and thus can be recommended during irrigation with EDTA to improve their efficacy at the end of the preparation.

– Machine-assisted agitation systems

The evolution of manual systems led to the introduction of instruments that can be rotated in handpieces at low speed inside the canal filled with irrigant. They are rotary brushes too large to be brought close to the working length; thus, they can be used effectively only in the coronal and middle thirds of the canal. Other similar instruments are files in plastic with a smooth surface and increased taper or with a surface with lateral plastic extensions, that have dimensions appropriate to achieve the working length if used after the canal preparation. Studies on these systems have shown conflicting results. In general, the results are better than with hand irrigation with a syringe, but lower than that of other more effective systems.

– Continuous irrigation during instrumentation

Recently, a new system for root canal preparation has been introduced to the market. This system uses a particular instrument with an abrasive surface that enlarges the canal via friction in a vibrating motion and allows irrigant to flow through the file itself. This system has shown excellent results in terms of respecting the anatomy and cleaning of difficult root canal anatomies, such as difficult isthmuses, oval canals or C-shaped canals. The low cutting efficiency of this system in some cases may limit its use in root canal preparation, but makes it an excellent additional technique to enhance the cleaning and disinfection of the root canal system at the end of the preparation. The concept of continuous irrigation was developed in the past with the use of mechanical instruments for sonic and ultrasonic preparation that could concurrently clean through the continuous release of irrigant. These techniques were then abandoned for various reasons related to the poor quality of the preparation itself.

– Sonic activation

Sonic activation has been shown to be an effective method for disinfecting the root canals. The recent systems use smooth plastic tips of different sizes activated at a sonic frequency by a handpiece. The system seems to be able to clean the main canal effectively, to remove the smear layer and to promote the filling of a greater number of lateral canals. Another recently introduced technique uses a syringe with sonic vibration that allows the delivery and activation of the irrigant in the root canal simultaneously. Sonic activation differs from ultrasonic activation in that it operates at a lower frequency (1–6 kHz), and for this reason it is generally found to be less effective in removing debris than are ultrasonic systems.

– Apical negative-pressure irrigation

As the irrigant must be in direct contact with the micro-organisms and canal walls to be effective, the accessibility of the irrigant to the whole root canal system, in particular in the apical third, is essential. In order to deliver the irrigant into the root canal for the entire length and to obtain a good flow of fluid, apical negative-pressure systems have been introduced that release and remove the irrigant simultaneously.

These systems consist of a macrocannula for the coronal and middle portions and a microcannula for the apical portion, and the cannulas are connected to a syringe for irrigation and the aspiration system integrated with the dental unit (Fig. 3). During irrigation, a tip connected with a syringe delivers the irrigant to the pulp chamber without the risk of overflow, while the cannula placed in the canal pulls irrigant into the canal, through the aspiration system to which it is connected, and evacuates it through the suction holes. This system is intended to ensure a constant and continuous flow of new irrigant into the apical third safely and with a lower risk of extrusion. Most of the studies on this technique have shown that it is very effective at ensuring a greater volume of irrigant in the apical third and excellent removal of debris from this area and in inaccessible areas, with results in the majority of cases similar to those of ultrasonic activation techniques. From a clinical perspective, apical negative-pressure systems can be effectively integrated with ultrasonic irrigation techniques because they act by different mechanisms. They can operate in synergy with the objective to obtain cleaner canals, especially in the apical third and the most inaccessible areas.

– Laser activation

The interaction between the laser and the irrigant in the root canal is a new area of interest in the field of endodontic disinfection. This concept is the base of laser-activated irrigation (LAI) and photonic-initiated photoacoustic streaming (PIPS) technology. The mechanism of this interaction has been attributed to the effective absorption of the laser light by NaOCl. This leads to the vaporization of the irrigant and to the formation of vapor bubbles, which expand and implode with secondary cavitation effects. The PIPS technique is based on the power of the Er:YAG laser to create photoacoustic shock waves within the irrigant introduced into the canal. When it is activated in a limited volume of liquid, the high absorption of the laser in NaOCl combined with the high peak power derived from the short pulse duration employed (50 μs) determines a photomechanical phenomenon. A study showed that there was no difference in bacterial reduction achieved by NaOCl activated by laser compared with only NaOCl. Another study investigated the capability of LAI to remove a bacterial biofilm created in vitro on the canal walls. This study found that it did not completely remove the biofilm from the apical third of the root canal and infected dentinal tubules. However, the finding that laser activation generated a higher number of samples with negative bacterial cultures and a lower number of bacteria in the apical third was a promising result regarding the effectiveness of the technique, and has been confirmed by a more recent study.

Additional disinfection systems

In addition to the above-mentioned systems that were able to activate the endodontic irrigants and to improve their...
cleaning capability, endodontic research is oriented toward the identification of alternative solutions that could further refine disinfection and assist in the destruction of biofilms and the elimination of microorganisms. For this purpose, different substances and technologies have been investigated over time with different results.

– Photoactivated disinfection

A new method recently introduced in endodontics is photoactivated disinfection. This technique is based on the principle that the photosensitizing molecules (photosensitizer, PS) have the ability to bind to the membranes of the bacteria. The PS is activated with a specific wavelength and produces free oxygen, which causes the rupture of the bacterial cell wall on which the PS is associated, determining a bactericidal action.34 Extensive laboratory studies have shown that the two components do not produce any effect on bacteria or on normal tissue when used independently of each other; it is only the combination of PS and light that exert the effect on the bacteria.34

An endodontic system called light-activated disinfection (LAD) has been developed based on a combination of a PS and a special light source. The PS attacks the membranes of micro-organisms and binds to their surface, absorbs energy from light and then releases this energy in the form of oxygen, which is transformed into highly reactive forms that effectively destroy micro-organisms. LAD is effective not only against bacteria, but also against other micro-organisms, including viruses, fungi and protozoa. The PSs have far less affinity for the cells of the body; therefore, toxicity tests carried out did not report adverse effects of this treatment. Clinically, after root canal preparation, the PS is introduced into the canal to working length with an endodontic needle and is left in situ for 60 s to allow the solution to come into contact with the bacteria and spread through any structures, such as biofilms. The specific endodontic tip is then inserted into the root canal up to the depth that can be reached and irradiation is performed for 30 s in each canal (Fig. 4). This technique has proven to be effective in laboratory studies at eliminating high concentrations of bacteria present in artificially infected root canals.35 Care should be taken to ensure maximum penetration of the PS, since it is important that it come into direct contact with the bacteria, otherwise the effect of photosensitivity will not occur. In addition, LAD appears to be effective not only against the bacteria in suspension, but also against biofilm.5 Research is now directed toward evaluating the possibility of increasing the antibiofilm effectiveness of LAD, combining the benefits of photodynamic therapy with those of bioactive glasses and nanoparticles, which will be described later. Currently LAD is not considered as an alternative, but rather as a possible supplement to standard protocols of root canal disinfection already in use.5

– Laser

One of the main disadvantages of the current endodontic irrigants is that their bactericidal effect is limited primarily to the main root canal. In the endodontic field, several types of lasers have been used to improve root canal disinfection: the diode laser, carbon dioxide laser, Er:YAG laser...
application of high-power lasers for direct
is not currently available to support the
tiveness of ozone was found not compa-
that of the classical solutions of
the laser has been found to be less relevant
elimination of the biofilm and bacteria has
not yet been possible, and the effect of
this limitation, a new delivery system of
consists of a tube that allows the emission of
radiation laterally instead, directed
along the canal and not necessarily later-
ally toward the walls. In order to overcome
the objective of this modification was to
improve the antimicrobial effect of the
laser in order to penetrate and destroy mi-
crobes in the root canal walls and in the
dentin tubules. However, complete
elimination of the biofilm and bacteria has
not yet been possible, and the effect of
the laser has been found to be less relevant
that of the classical solutions of
In conclusion, strong evidence
sidered interest for endodontic disinfec-
son it was also used in endodontics. How-
the enlargement of the root canals be-
the chemical and physical properties of
dentin and reduce the strength of adhe-
sion of bacteria to the dentin itself, thus
limiting recolonization and bacterial
biofilm formation. In any case, the possible
success of the application of nanoparticles
in endodontics will depend essentially on
the manner in which they can be delivered
in the most complex root canal anatomy.

Bioactive glass
Recently, bioactive glass or bioactive
glass-ceramics have been a subject of con-
siderable interest for endodontic disinfection
owing to their antibacterial properti-
ies, but conflicting results have been
obtained.5

Natural plant extracts
A current trend is the use of natural plant
extracts, taking advantage of the antibac-
terial activity of polyphenolic molecules
generally used for storing food. These
compounds have been found to have poor
antibacterial efficacy, but several demon-
strate significant ability to reduce the for-
mation of biofilms, although the mecha-
nism by which this occurs is not clear.5

Noninstrumentation techniques
The first trial of a method of cleaning with-
out canal preparation was the noninstru-
mentation technique conceived by Lussi
This technique did not provide for
the enlargement of the root canals be-
cause there was no mechanical instrumen-
tation of the root canal walls. In fact, root
channel cleaning was exclusively obtained with
the use of NaOCl at low concentra-
tion, introduced and removed from the
canal using a vacuum pump and an electric
piston that created fields of alternating
pressure inside the canal. These caused the
implosion of the produced bubbles and
hydrodynamic turbulence that facilitated
the penetration of NaOCl into the root
canal ramifications. At the end of this pro-
cedure, the canals were filled with a ce-
ment conveyed by the same vacuum pump. This system did not prove to be of
substantial effectiveness and was never
marketed.

Recently, a method has been developed for
cleaning the entire root canal system through the use of a broad spectrum of
sound waves transmitted within an irrigat-
solution to remove pulp tissue, debris
and micro-organisms quickly. One study
showed that this technique was able to dis-
solve the tissue tested at a rate signifi-
cantly higher than that of conventional ir-
rigation.6 More research is needed to
determine whether this approach is effec-
tive in the root canal system with mini-
mally invasive or no canal preparation.

Conclusion
According to current knowledge, endo-
dontic pathology is an infection mediated
by bacteria and in particular by biofilm.
From a biological perspective, endodontic
therapy must then be directed toward the
elimination of micro-organisms and the
prevention of possible reinfection. Unfor-
nately, the root canal system, with its
anatomical complexity, represents a chal-
lenging environment for the effective re-
moval of bacteria and biofilm adherent to
the canal walls. Chemomechanical prepara-
tion involves mechanical instrumenta-
tion and antibacterial irrigation, and it is
the most important phase of the disinfec-
tion of the endodontic space. The techno-
logical advances of instruments have
brought significant improvements in the
ability to shape the root canals, with fewer
procedural complications. In the manage-
ment of the infected root canal system,
various antimicrobial agents have been
employed. Furthermore, some clinical
measures, such as an increase in apical
preparation and a more effective system
of irrigant delivery and activation of irri-
gant, can promote and make more pre-
dictable the reduction of intracanal bac-
teria, especially in complex anatomical and
noninstrumented portions of the root
canal system.

Editorial note: A list of refer-
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COMPARATIVE STUDY
— of implant placement torque and resonance frequency analysis on the implant and abutment

Introduction
The long-term clinical success of dental implants is dependent upon osseointegration, which is defined as a direct functional and structural connection between the bone and implant surface. Primary stability is, therefore, paramount. Several methods have been used to determine implant stability; however, resonance frequency analysis (RFA) is considered the most accurate. Despite RFA having been used since 1980 in orthopedics, it has only been used in implantology since the 1990s, when it was described by Meredith and has been widely used ever since.

When evaluating the stability of implants, quantitative methods such as RFA can yield valuable information that could contribute to long-term treatment success. RFA allows measurements of stability on a numerical scale ranging from 0 to 100, and such measurements can be obtained soon after implant placement or at any time during healing. According to Nerdrum et al., RFA may aid in the decision-making process regarding the best time for seating of the prosthesis on the implant during the healing period.

Currently, the demand for esthetic dentistry is increasing; therefore, immediate loading approaches, in which the prosthesis is seated on the implant in the same session, have been widely used. Nevertheless, load can only be applied if the implant presents sound primary stability. Further torque will be applied when seating the abutment on the implant, which may prevent future RFA measurements directly on the implant, since removal of torqued abutments may impair osseointegration during the healing period.

In order for an implant to be able to receive immediate loading, it is necessary for the final placement torque to be high. However, studies comparing RFA with measurements obtained directly from the implant and abutment combined are scarce. Therefore, the objectives of the present study were to analyze the resonance frequency of the implant and abutment set immediately after placement and to compare them with the final placement torque.

Patient selection
Nine patients, five males and four females, were evaluated in this study, with 17 implants being placed in different areas of both arches. The patients were attended to by undergraduate students of the São Leopoldo Mandic dental school (Campinas, Brazil) throughout 2014. The patients were assessed and those found not to have any systemic diseases that would affect the healing process of the implant were included. Patients with a systemic disease or insufficient bone quality were excluded.

Preoperative procedures
Each patient underwent computed tomography scans in order to survey the area where the implant would be placed, as well as to classify the type of bone, including height and width measurements in order to select the most suitable implant design for each situation. A full blood count and coagulation screen were performed for each patient.
Intraoperative procedures

The surgical procedures followed asepsis guidelines and were performed under local anesthetic. A #15c scalpel blade was used to make an incision along the bone crest and, subsequently, a full mucoperiosteal flap was raised. The surgical guide was inserted and bone drilling performed following the manufacturer’s recommendations.

After preparation of the surgical socket, a Neodent Morse taper connection implant was placed. It was initially placed using an electric motor and finalized with a manual torque wrench. The final placement torque was recorded for subsequent comparative analysis. Upon completion of implant placement, a specific transducer was fixed inside the implant (Fig. 1a) and, subsequently, the implant resonance frequency was measured (Fig. 1b) using the Osstell device. The implant was then torqued to a screwed abutment and, in turn, a specific transducer was set inside the abutment (Fig. 2a). At this point, the resonant frequency of the abutments was measured using the same equipment (Fig. 2b).

The resonance frequencies, both from the implant and the abutment, were taken from the buccal, mesial, distal and lingual aspects, and a mean value was obtained for each region. After the last measurement, an abutment protection cylinder or temporary restoration was placed and the flap sutured.

Statistical analysis

The placement torque and stability were analyzed separately for each implant and...
abutment using nonparametric tests. Data were analyzed comparatively using the Wilcoxon and Pearson correlation tests, at a significance level of 5%.

**Results**

The mean values and standard deviations for implant and abutment placement torques (in N cm) and RFA (in ISQ) were 53.5 ± 19.7, 67.6 ± 8.4 and 52.8 ± 2.8, respectively (Table 1; Figs. 3–5).

Statistical analysis did not find a linear pattern between the measurements of placement torque and ISQ, either on the implant (−0.24) or the abutment (−0.18). Regarding the comparison between ISQ for the implant and abutment, despite a significant numerical difference (p < 0.05), a linear pattern was observed (0.68).

**Discussion**

RFA is a reliable method for measuring the stability of dental implants and this finding has recently been reported by several authors.7, 9, 10, 12–15 It is commonly measured using an Osstell device immediately after implant placement or at any time during the healing process, as well as after loading of the implants.4 Park et al. demonstrated that two different directional measurements are needed for RFA, since this allows the detection of ISQ change patterns that would not be identified if only unidirectional measurement was used.16 This information influenced the decision-making process in the present study, since two RFA measurements were taken for each implant, one from the buccal and the other from the lingual aspect, and the average was then calculated.

In the present study, mean values and standard deviations for placement torque (in N cm) and RFA (in ISQ) on both the implant and abutment on the day of implant placement (53.5 ± 19.7, 67.6 ± 8.4 and 52.8 ± 2.8, respectively) were analyzed. No obvious linear pattern was observed. When the measurements of ISQ on the implant compared with placement torque were compared, the linear correlation coefficient was −0.24. This corroborates the findings of Schliephake et al.17 and Akça et al.,18 yet contradicts the results of Friberg et al.15 and Turkylıma et al.20 When comparing the ISQ values on the abutment with placement torque, no linear pattern was observed; the linear correlation coefficient was −0.18. Therefore, if RFA is accepted as the most suitable method for determining the best time for implant loading, it can be speculated that the placement torque measurement would be unnecessary. However, Esposito et al.,11 in a literature review, argued that if an immediate loading approach is considered among the treatment options, then the implant must be placed with a high torque, which usually exceeds 30 N cm21 or 40 N cm.22 Therefore, RFA and torque are two distinct methods for analyzing implant stability and both should be considered. The main difference between them is that ISQ can be measured months after implant placement, whereas torque can only be measured on the day of surgery, which makes the latter a weak method for

### Table 1

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<th>Measurement</th>
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<th>Median</th>
<th>Lower</th>
<th>Upper</th>
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</thead>
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<tr>
<td>Torque (N cm)</td>
<td>53.5</td>
<td>19.7</td>
<td>45</td>
<td>25</td>
<td>100</td>
<td>17</td>
</tr>
<tr>
<td>RFA on implant (ISQ)</td>
<td>67.6</td>
<td>8.4</td>
<td>68</td>
<td>47</td>
<td>78</td>
<td>17</td>
</tr>
<tr>
<td>RFA on abutment (ISQ)</td>
<td>52.8</td>
<td>2.8</td>
<td>52</td>
<td>47</td>
<td>57</td>
<td>17</td>
</tr>
</tbody>
</table>

Fig. 3 Association analysis between the measurements ISQ over implant vs. placement torque.

Fig. 4 Association analysis between the measurements ISQ on abutment vs. installation torque.
analyzing secondary or biological stability. ISQ is a reliable method for implant follow-up and the initial base value should be recorded in order for the clinician to have a reference for maintenance purposes. Implant failures are occasionally difficult to diagnose and the comparison against the initial ISQ value can be a useful approach to assessing risk of implant failure.

Analysis of the association between the ISQ values on the implant and on the abutment indicated a linear pattern in the data, as the linear correlation coefficient was 0.68. However, a significant difference was observed in terms of the mean ISQ value measured on the implant and on the abutment (p < 0.05), with the highest values observed on the implant. Many studies have demonstrated that implants with a high initial ISQ value (> 60) are often successfully osseointegrated and tend to perform well clinically in the long term. Sennerby and Meredith state that low initial ISQ values that continue to decrease as healing progresses may be a sign of implant failure. Glauser et al. report an implant failure rate of 11.2%. The implants with an initial ISQ value of higher than 69 had a 100% success rate, while those with an initial ISQ value of between 48 and 59 had an average failure rate of 19%, and 100% of the implants with an initial ISQ value of lower than 39 failed.

No studies were found that compared ISQ on the implant and the abutment at the same surgical intervention, which was the approach chosen in this study. The ISQ values for each implant and abutment were very far apart, despite the results showing a linear pattern between them. This finding complicates the use of RFA on implants where an abutment is torqued in the same session as the implant, since removal of the abutments torqued during the osseointegration period is not indicated. Therefore, when the ISQ value for an implant at the time of placement is less than 60, an abutment should not be torqued during the same session, since such a scenario contraindicates immediate loading. Measurements at the implant level are regarded as the most accurate approaches to defining the loading protocol for any particular prosthesis; however, measurements at the abutment level could be the safest way to follow up on dental implants, since premature abutment removal could result in implant failure. Because of the linear correlation identified between both measurements, abutment ISQ or implant ISQ values could be used equally.

Based on the results presented in this study, less accuracy was observed in the measurement of ISQ when the abutment was seated in the same surgical session, which is essential for immediate loading. Owing to the lack of studies using the same methodology, further investigation is needed in order to develop methods that are more accurate for evaluation of ISQ on abutments. In addition, studies comparing RFA on implants and abutments of different implant systems would be desirable. Therefore, it can be concluded in the present study that no association was found between the measurements of placement torque and RFA. Additionally, a statistically significant difference was identified between the implant and abutment ISQ measurements.

Editorial note: A list of references is available from the publisher.
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