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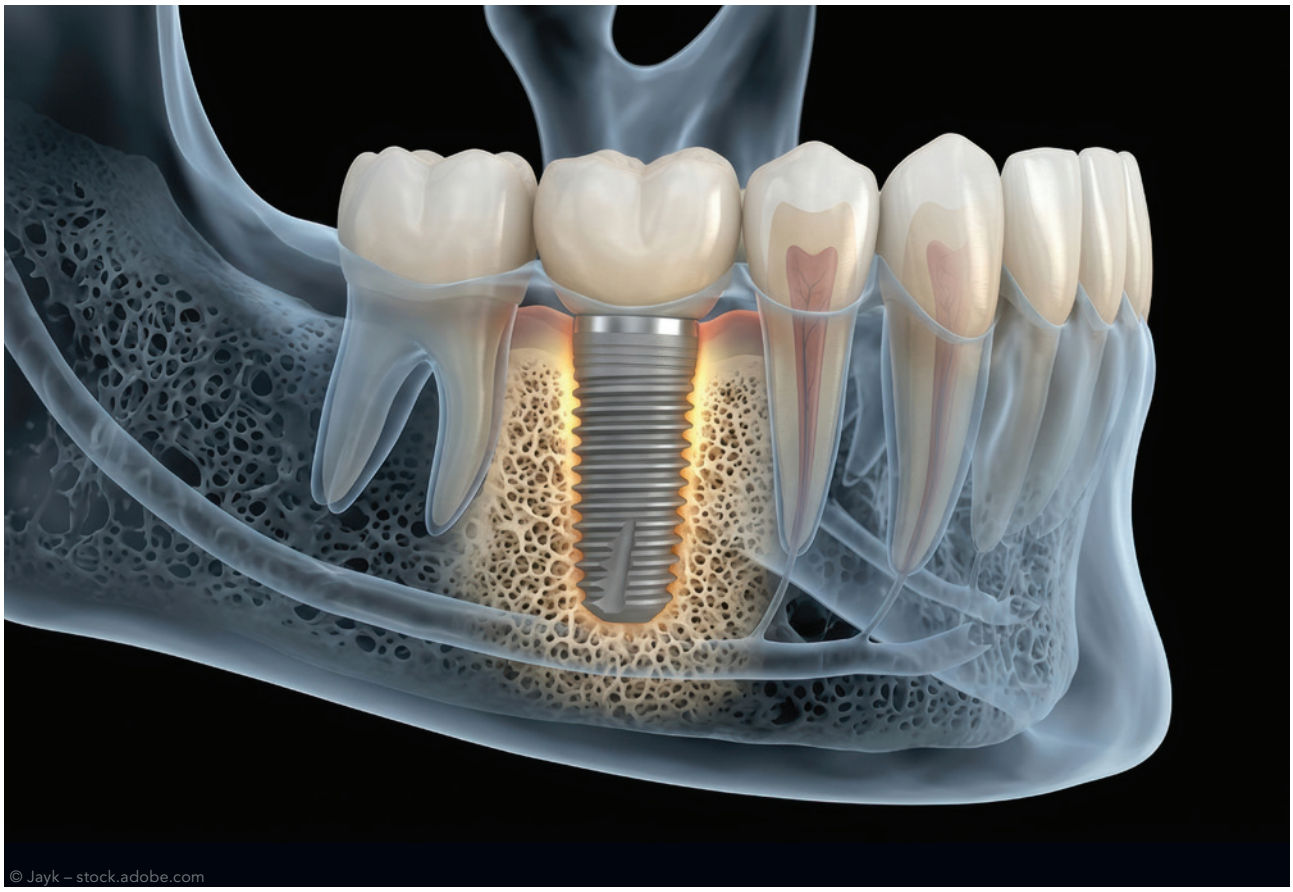
international magazine of **oral implantology**

research
Rethinking implant osteotomy preparation

case report
Vertical ridge augmentation in the atrophic posterior region of the mandible

events
Implant dentistry meets the "Florence on the Elbe"



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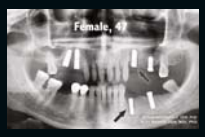

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Dr Georg Bach
President
of the DGZI

Rooted in evidence

Advancing implantology through practice and exchange

Dear colleagues

Oral implantology continues to advance through scientific research, clinical experience and open professional exchange. Reflecting this diversity, the current issue brings together contemporary clinical approaches, research perspectives, industry developments and opportunities for international dialogue. Its overarching aim is clear: to support informed decision-making and contribute to reliable, patient-centred care.

A particular emphasis is placed on clinical practice and the challenges encountered in modern implantology. Through case-based contributions, the issue demonstrates how treatment planning, surgical technique and the appropriate selection of instruments and procedures converge across a range of clinical scenarios.

One key topic is implant osteotomy preparation. The featured material examines relevant biomechanical principles alongside practical considerations, including progressive wear, diminished sharpness and the risk of

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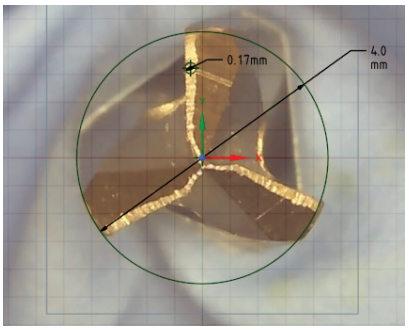
Dr Gregori M. Kurtzman



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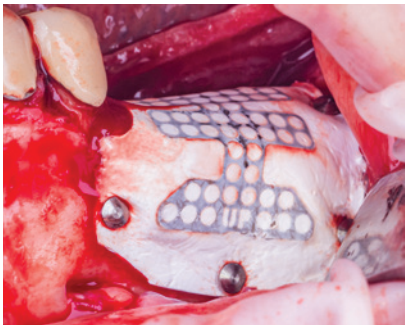

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brittleness under excessive loading. These factors highlight the importance of understanding not only the technique itself, but also the properties and limitations of the instruments involved.

Further contributions explore fully guided full-arch rehabilitation, as well as immediate implant placement combined with simultaneous guided bone regeneration in a complex patient case. Together, these reports reflect the breadth of contemporary implant treatment, from preparatory surgical procedures to comprehensive rehabilitation and combined implant and regenerative therapies.

The cases underscore the wide-ranging clinical demands of implant dentistry and provide a valuable basis for evaluating different approaches and their application in daily practice. Throughout, the central objective remains the same: the careful, individualised management of each clinical situation.

Beyond its clinical content, this issue also presents news from the dental industry and highlights opportunities for professional exchange at forthcoming international events.

I hope this edition offers valuable perspectives, encourages critical reflection and supports your daily professional practice. I wish you an informative and inspiring read.

Yours sincerely
Dr Georg Bach
President of the German Association of
Dental Implantology—DGZI

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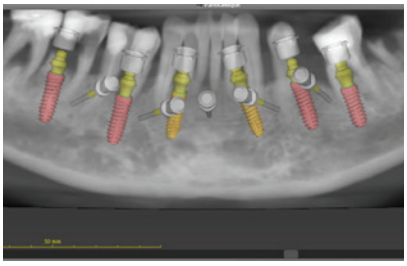

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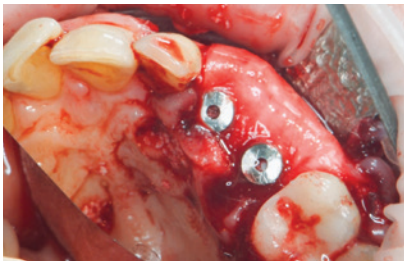

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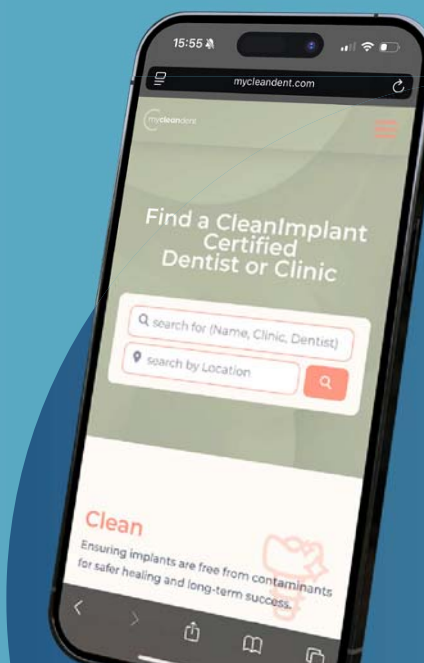

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Rethinking implant osteotomy preparation

Material science, biomechanics, and the crown down concept

Implant osteotomy preparation has remained fundamentally unchanged for more than five decades despite significant advances in implant design, surface technology, digital treatment planning, and guided surgery. Conventional sequential drilling using stainless steel drills has demonstrated excellent long-term clinical success but is associated with progressive drill wear, reduced cutting efficiency, multiple drilling steps, and increased frictional heat generation with repeated use.

Dr Gregori M. Kurtzman, USA

Solid tungsten carbide possesses exceptional hardness, wear resistance, and cutting-edge retention, making it an attractive alternative material for implant drills. However, its relatively brittle mechanical behaviour has historically limited its clinical application because conventional pilot-to-final drilling sequences expose the smallest drills to the highest torsional and bending stresses. The Crown Down concept was developed to overcome this engineering limitation by redistributing drilling forces so that the largest and mechanically strongest drill prepares the dense cortical bone before smaller drills complete the trabecular osteotomy. This review examines the scientific rationale behind this alternative osteotomy philosophy, emphasising material science, biomechanics, drill wear, thermal considerations, osteocompression, autogenous bone harvesting, and potential clinical applications. Although preliminary laboratory and clinical evidence is encouraging, additional prospective comparative studies are needed to determine whether these engineering advantages translate into superior long-term clinical outcomes.

Introduction

Successful implant therapy depends on precise osteotomy preparation. The implant osteotomy determines implant position and angulation while influencing primary stability, surgical efficiency, heat generation, and the biologic response of surrounding bone during healing. Although implant macrodesign, surface technology, digital treatment planning, and guided surgery have evolved considerably over the past three decades, the fundamental principles of implant site preparation have changed remarkably little.[1–4] Conventional implant osteotomies continue to be prepared using sequential stainless-steel drills that progressively enlarge the osteotomy from a narrow pilot drill to the final implant diameter. This technique has demonstrated excellent long-term clinical success and remains the benchmark against which alternative osteotomy protocols should be evaluated. However, sequential drilling requires multiple drill changes and repeatedly exposes each drill to dense cortical bone, contributing to progressive drill wear, reduced cutting efficiency, increased friction, and greater thermal generation during osteotomy preparation.[2–7]

These limitations have stimulated interest in alternative cutting materials capable of maintaining sharp cutting edges over prolonged clinical use. Solid tungsten carbide possesses exceptional hardness, wear resistance, and cutting-edge retention, making it an attractive alternative to stainless steel.[6–8] However, its relatively brittle mechanical behaviour has historically limited its application because conventional pilot-to-final drilling sequences expose the smallest drills to the highest torsional and bending loads while penetrating dense cortical bone. The Crown Down concept was developed to overcome this engineering limitation by reorganising osteotomy preparation according to the mechanical properties of both bone and drill material rather than simply enlarging the osteotomy sequentially. This review examines the scientific rationale, biomechanics, material science, and potential clinical applications of this alternative osteotomy philosophy.

Why implant drills wear

A bone is an exceptionally demanding cutting substrate because cortical bone contains approximately 60 to 70 per cent mineral by weight, primarily hydroxyapatite, producing substantial abrasive forces during implant osteotomy

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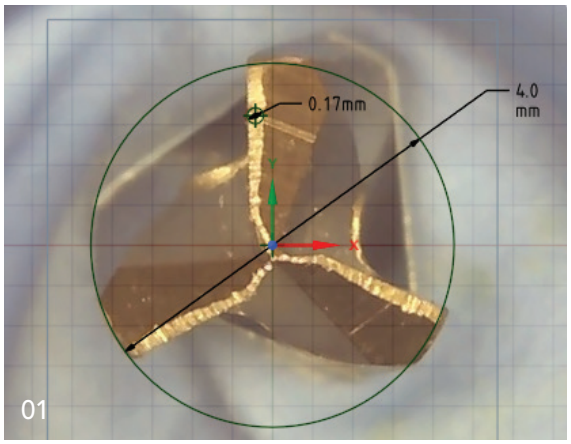
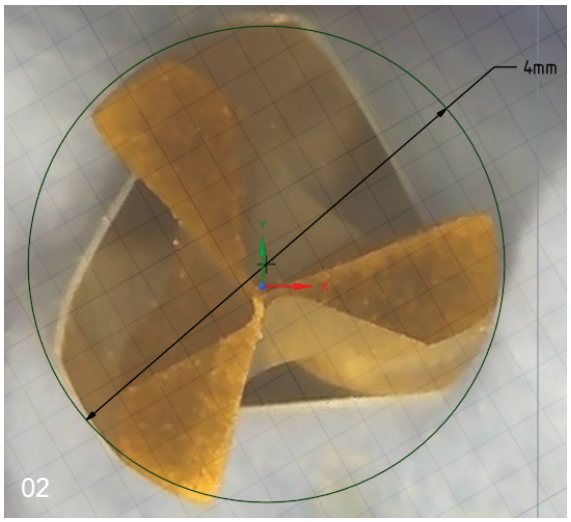




01
Wear noted on stainless steel drill after repeated osteotomy preparation use.

02
Lack of wear noted on tungsten carbide drill after repeated osteotomy preparation use.

preparation.[3–7] As stainless-steel drills are used repeatedly, scanning electron microscopy has demonstrated progressive cutting-edge rounding, abrasion, microchipping, and surface deformation that reduce cutting efficiency (Fig. 1).[3–5]

Loss of cutting efficiency has important clinical consequences. Dull drills require greater axial pressure and longer contact time to remove bone, increasing friction at the cutting interface and generating additional heat. Eriksson and Albrektsson demonstrated that prolonged exposure of bone to temperatures above approximately 47 °C may result in irreversible thermal injury, emphasising the importance of maintaining sharp cutting instruments during implant surgery.[1] Drill longevity is also influenced by bone density, drill design, rotational speed, irrigation, surgical technique, and repeated sterilisation cycles.[2–7]

These observations have prompted investigation of more wear-resistant cutting materials. Solid tungsten carbide maintains a sharp cutting edge substantially longer than stainless steel and therefore has the potential to reduce friction while maintaining cutting efficiency.[6–8] In contrast to the progressive wear observed with stainless-steel drills, Figure 2 demonstrates the minimal cutting-edge wear evident in a solid tungsten carbide drill following repeated osteotomy preparation.

Material science of implant drills

The clinical performance of an implant drill depends on both its design and the properties of the material from which it is manufactured. An ideal drill should maintain a sharp cutting edge, efficiently remove bone with minimal friction, resist corrosion and repeated sterilisation, dissipate heat effectively, and tolerate the torsional and bending forces encountered during surgery.

For decades, surgical stainless steel has been the material of choice because it combines strength, toughness, corrosion resistance, ductility, and relatively low manufacturing cost. One of its greatest advantages is its ability to deform before fracturing under excessive loading, providing an important margin of clinical safety. Its primary limitation is progressive cutting-edge wear, which increases drilling resistance, friction, and thermal generation with repeated clinical use. [2–7]

Solid tungsten carbide offers a distinctly different combination of mechanical properties. Its exceptional hardness and abrasion resistance allow it to retain a sharp cutting edge considerably longer than stainless steel, improving cutting efficiency while potentially reducing friction and heat generation.[6–8] However, unlike stainless steel, tungsten carbide undergoes very little plastic deformation before fracture. Consequently, successful clinical application depends not only on the drill material itself but also on a drilling sequence that minimises excessive torsional and bending stresses. The principal differences between stainless steel and solid tungsten carbide implant drills are summarized in Table 1. Comparing the relative hardness of materials commonly used for implant drill manufacture, solid tungsten carbide demonstrates substantially greater hardness than ceramic, titanium, and stainless steel (Fig. 3). This exceptional hardness allows the drill to maintain a sharp cutting edge through repeated osteotomy preparation, reducing abrasive wear and preserving cutting efficiency over a greater number of clinical procedures. However, hardness alone does not determine clinical performance. Because tungsten carbide is considerably less forgiving under excessive torsional and bending loads than stainless steel, successful clinical application requires a drilling sequence designed to minimise these stresses.

The engineering challenge

If solid tungsten carbide possesses such favourable cutting characteristics, why has it not replaced stainless steel for implant drills? The answer lies in fracture mechanics. Conventional implant osteotomy preparation begins with a narrow pilot drill that establishes implant position and angulation before progressively enlarging the osteotomy with increasingly larger drills.[1–4] Consequently, the smallest drill must penetrate dense cortical bone and is exposed to the greatest torsional and bending loads.

While stainless steel can tolerate these stresses through elastic and plastic deformation, similarly sized tungsten carbide

Property	Stainless steel	Solid tungsten carbide	Clinical significance
Hardness	Moderate	Very high	Improved resistance to cutting-edge wear
Wear resistance	Moderate	Excellent	Longer maintenance of cutting efficiency
Fracture toughness	High (ductile)	Lower (brittle)	Requires modified drilling sequence to minimise overload
Flexibility	Greater	Limited	Steel tolerates bending; carbide is less forgiving under excessive lateral stress
Cutting-edge retention	Moderate	Excellent	Reduced drilling forces over repeated use; more efficient heat transfer away from the cutting interface
Thermal conductivity	Moderate	Higher	More efficient heat transfer away from the cutting interface
Resistance to repeated sterilisation	Good	Excellent	Maintains dimensional stability with repeated clinical use
Cutting efficiency	Decreases progressively with wear	Maintained more osteotomies	May reduce friction and drilling time
Typical clinical limitation	Progressive wear and loss of sharpness	Brittleness under excessive torsional or bending loads	Forms the biomechanical basis for the Crown Down concept

Table 01
Comparison of stainless steel and solid tungsten carbide implant drills.

drills are considerably more susceptible to brittle fracture.[6–8] Simply substituting tungsten carbide for stainless steel within a conventional ascending drilling sequence would therefore expose the smallest carbide drills to the highest mechanical loads, increasing the likelihood of fracture. The engineering limitation lies not in the material itself, but in the drilling sequence.

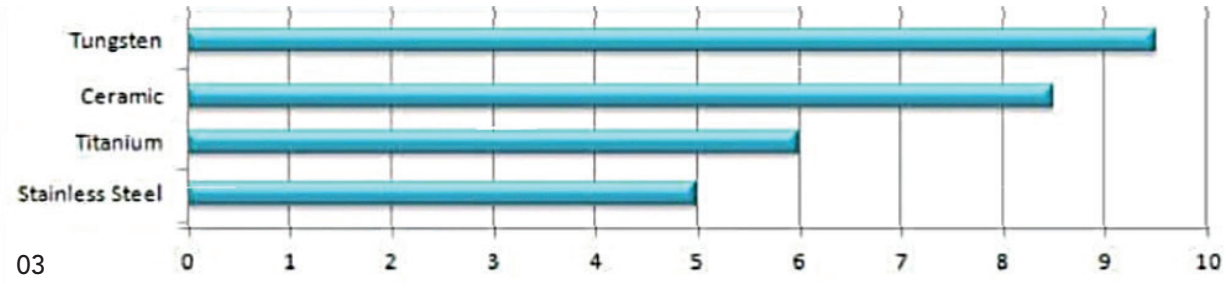
The Crown Down concept

The Crown Down concept was developed by Dr Zvi Fudim to address the principal engineering limitation associated with the use of solid tungsten carbide implant drills. Rather than exposing the smallest drills to the greatest mechanical stresses, the drilling sequence is reorganised so that the largest and mechanically strongest drill encounters the highest resistance first.

Unlike conventional implant systems, the Crown Down approach does not simply reverse the traditional sequential drilling protocol. Instead, the drilling sequence is designed around the mechanical properties of tungsten carbide and the differing resistance characteristics of cortical and trabecular bone. Drill selection is determined by implant diameter and the portion of the osteotomy being prepared rather than by progressively enlarging the osteotomy from a small pilot drill to the final diameter. The principal differences between conventional sequential drilling and the Crown Down concept are summarised in Table 2.

One commercially available implementation of this concept is the Crown Down Kit (Crown Down), which incorporates solid tungsten carbide drills organised according to this engineering philosophy. Unlike conventional implant systems that begin with a 2.0 mm pilot drill, the smallest drill in the kit is selected according to the planned implant diameter. For example, preparation of a 3.2 mm implant osteotomy utilises a 2.75 mm drill rather than a 2.0 mm pilot drill, thereby avoiding unnecessary use of extremely small tungsten carbide drills that would otherwise be exposed to high torsional stresses. The range of available Crown Down tungsten carbide drills, which are selected according to the planned implant diameter rather than by a conventional pilot-to-final sequence (Fig. 4).

For placement of a 4.8 mm implant, the sequence begins with a larger-diameter cortical drill corresponding to the planned implant diameter. Because this drill possesses substantially greater cross-sectional area and bending stiffness, it is considerably more resistant to torsional overload than smaller drills. Its primary purpose is to relieve the



03

03
Relative hardness comparison of materials commonly used for implant drill manufacture.

All images: © Dr Gregori M. Kurtzman

dense cortical plate, which represents the region of greatest drilling resistance. The progressive Crown Down drilling sequence (Fig. 5) demonstrates how the osteotomy is enlarged incrementally from the crestal cortex toward the final working depth while reducing cortical resistance before deeper preparation.

Once the cortical bone has been prepared, smaller tungsten carbide drills are used only within the deeper trabecular portion of the osteotomy. At this stage, the cortical resistance has already been eliminated, allowing the smaller drills to function under substantially lower mechanical loads. Consequently, they experience reduced binding, lower lateral bending forces, decreased torsional stress, and a markedly reduced likelihood of brittle fracture. The simplified two-drill Crown Down protocol is illustrated in Figure 6. A cortical drill matching the planned implant diameter enlarges only the crestal portion of the osteotomy to relieve cortical resistance (A), after which a final implant-specific drill completes the osteotomy to the planned depth and diameter (B). This approach replaces the conventional five- to eight-drill sequential protocol while reducing instrument changes and mechanical loading on the drills.

This sequence is fundamentally different from simply manufacturing conventional implant drills from tungsten carbide. If solid tungsten carbide drills were used in the traditional ascending pilot-to-final sequence, the smallest drills, particularly those measuring approximately 2.5 to 3.0 mm in diameter would be subjected to the greatest torsional and bending stresses while penetrating dense cortical bone. Because tungsten carbide exhibits limited plastic deformation prior to failure, such loading conditions would substantially increase the risk of sudden brittle fracture.

Accordingly, the innovation of the Crown Down concept lies not simply in the use of tungsten carbide as a cutting material, but in the integration of material science with drill architecture and surgical biomechanics. By matching drill diameter, drilling order, and regional bone resistance to the mechanical behaviour of solid tungsten carbide, the system enables the safe clinical application of a material that would otherwise be poorly suited to a conventional sequential drilling protocol.

Cortical bone is the real obstacle

One of the fundamental principles underlying the Crown Down concept is recognising that not all bone contributes equally to drilling resistance. Cortical bone is highly mineralised and possesses an elastic modulus several times greater than cancellous bone, accounting for most drilling torque, drill wear, and heat generation during osteotomy preparation.[2–8] In contrast, trabecular bone offers substantially less resistance. Conventional sequential drilling repeatedly enlarges the cortical plate with every drill, whereas the Crown Down concept prepares the cortical bone once before completing the osteotomy within the less resistant trabecular bone. This reduces torsional stress on smaller drills, decreases cumulative friction, and

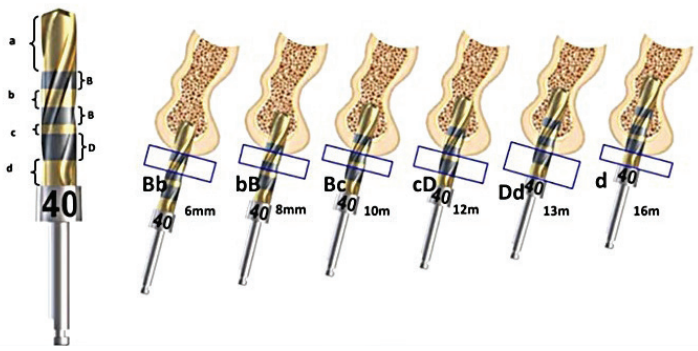
Characteristic	Conventional sequential drilling	Crown Down concept
Initial drill	2.0 mm pilot	Implant-specific cortical drill
Smallest drill used	2.0 mm	Implant diameter dependent (e.g. 2.75 mm for a 3.2 mm implant)
Cortical preparation	Repeated with every drill	Performed once by the largest drill
Region of highest mechanical stress	Smallest drill	Largest drill
Drill material	Stainless steel	Solid tungsten carbide
Typical number of drills	4 or more	2
Primary engineering objective	Sequential enlargement	Mechanical load redistribution
Risk of brittle carbide fracture	High if carbide substituted directly	Reduced by Crown Down architecture

Table 02
Conventional sequential drilling versus the crown down concept.

04

04
The diameters available for the tungsten carbide Crown Down drills.

05
Crown Down osteotomy preparation using a 4.0 mm drill, with sequential advancement progressively enlarging the osteotomy from the crestal cortex to the final depth, reducing drilling torque and heat generation.



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