

CLINICAL EXCELLENCE

Practical implantology, part three

IN THE THIRD PART
OF HIS SERIES ON
IMPLANTOLOGY IN
THE PRACTICE, SIMON
ALLUM LOOKS AT
ABUTMENT
CONNECTION DEVICES



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In part two of this series it was explained how Cigna, a major medical insurer, offer patients in the UK a formal warranty on dental implant treatments.

However, cover is limited to treatments provided using only the following systems that are reviewed further in this article:

- Astra (Astra Tech)
- Branemark & Replace (Nobel Biocare/Steri-oss)
- Frialit 2 (General Medical)
- ITI (Straumann)
- Osseotite (3i).

In considering the above systems, we have already looked at the bone/implant interface, the effect of the endosseous surface technology and the subsequent move of the industry away from the machined surfaced implants as first introduced by Branemark to the commercial market in the 1970s. In this, the third part in the series, we will look at abutment connection devices and consider issues including their biocompatibility and interaction with the surrounding and supporting soft and hard tissues.

The superstructure of any implant-borne restoration is carried on the abutments, which, in turn are joined to the implant fixtures via abutment connections. Abutment connection devices play primary roles in the reliability of the superstructure (in terms of the incidence and risk of crown loosening, abutment screw fractures, and other inconveniences), as well as having a direct effect on the

ease of use for the restorative surgeon.

THE CONCEPT OF THE BIOLOGIC WIDTH

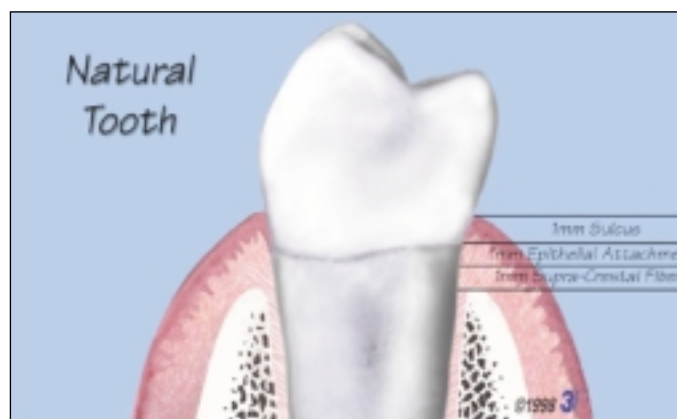
Gingival aesthetics around natural teeth are based upon a constant vertical dimension of healthy periodontal soft tissues above the underlying and supporting alveolar bone - the biologic width (Figure 1). This concept of the relationship between alveolar bone levels and the subsequent location of the gingival margin around natural teeth is employed in procedures such as crown lengthening surgery and orthodontic forced eruption techniques. Vertical alteration of the alveolar crestal margins is accompanied by a corresponding migration of the complete dento-gingival junction. Soft tissue anatomy and gingival architecture, (which are so important in the achievement of healthy, stable and aesthetically pleasing implant reconstructions) are

subject to similar considerations.

Where the biologic width is invaded or insulted by a poorly planned or badly engineered dental restoration, a tissue response will ensue to re-establish the hard and soft tissues in a more apical relationship. An example to illustrate this concept might be one where a restoration has margins that extend excessively below the gingival margin. Such a restoration will invade the established biologic width, and is likely to incite an inflammatory response in the surrounding connective tissues. This inflammation may only resolve once the insult to the biologic width no longer exists - either by a process of removal of the offending margins of the restoration, or subsequent to the process of marginal bone loss with accompanying soft tissue recession.

The biologic width has been shown to be a remarkably consistent measurement, maturing at around 3 to 3.5mm

Figure 1: The biologic width around a natural tooth



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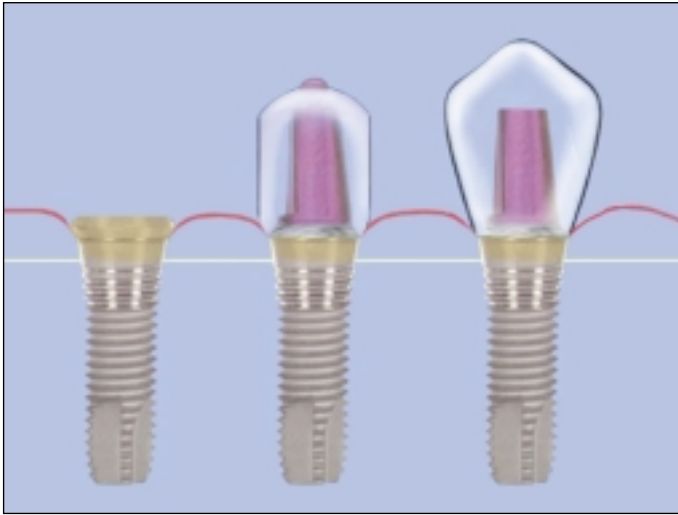


Figure 2: 3i Transmucosal TG implants featuring gold gingival collars for enhanced aesthetic effect. The white line represents the crestal bone level at placement, and subsequent to treatment. The red line represents the gingival contour

above the supporting bone level subsequent to abutment connection. Some slight variations will occur depending upon the implant type employed, but any reconstruction that relies on a soft tissue height in excess of the above dimensions is likely to be prone to gingival recession. This concept is of clinical relevance where implant fixtures are placed too deeply, or where overambitious gingival papilla reconstruction is attempted.

Dedicated transmucosal implants (e.g. standard ITI / Straumann or 3i TG Osseotite implants - Figure 2) are designed to compliment these documented soft tissue dimensional requirements, negating the need for a subgingival connection in the overall reconstruction. Conversely, two stage implant fixtures (whether used in a single stage or a two stage surgical technique) introduce the need for a deep subgingival connection. From a biological viewpoint, the disadvantage of introducing a connection at or near the bone crest is the risk of introducing a microgap between components that may become a challenge to the biologic width

and incite gingival recession and crestal bone loss. It has been shown that a microgap of 50 microns is clinically significant, allowing bacterial colonisation and the risk of a significant and detrimental hard and soft tissue response. A microgap of this order may be a feature of components of certain implant systems, but can also occur where an abutment connection of any non-transmucosal implant fixture loosens or begins to fail. Such a situation must be considered as a possible complication in any case which shows signs of inflamed peri-implant soft tissues.

EXTERNAL HEX CONNECTIONS

The external hex connection is essentially a male extension of the implant fixture, which fits inside the female abutment. The two components are locked together by a third component - the abutment screw. External hex connections have enjoyed a massive global market as a result of the original Branemark implant design concept, with many imitation implant systems springing up (and many fading away again) throughout the world. Imitation systems

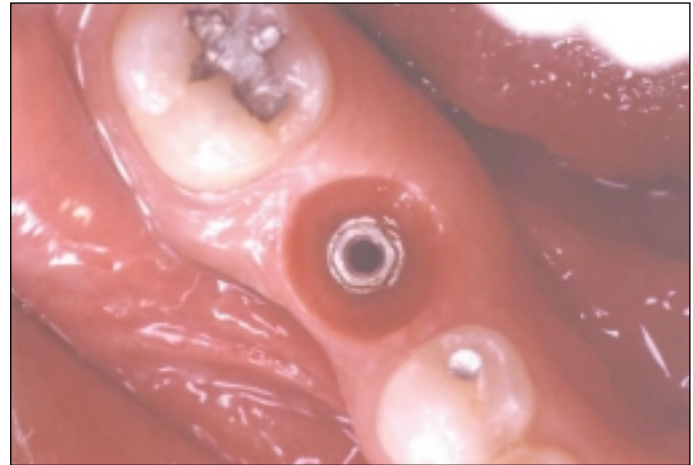


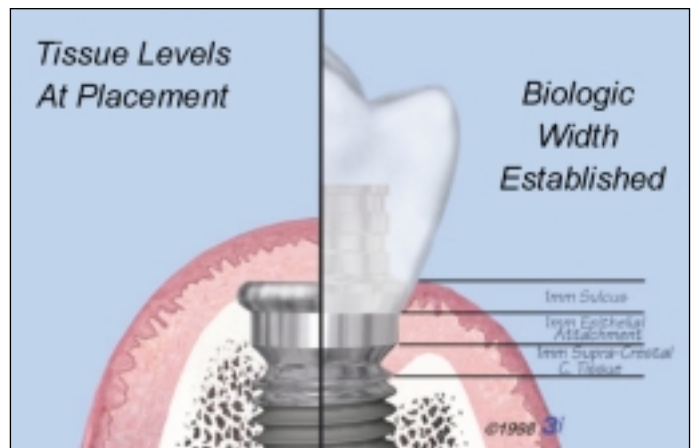
Figure 3: External hex implant in situ, awaiting restoration

advertise that components are interchangeable with branded parts. The standard hex is only 0.7mm high and is an anti-rotational locating device for a butt-joint abutment connection as featured on Branemark and 3i implant fixtures (Figure 3). From a mechanical viewpoint this design has been shown by many studies to be lacking in its resistance to laterally applied bending forces. Rotational play between male and female components represents movement in another axis that has received attention, highlighting the need for high accuracy machining of the

respective components. Biomechanical failure of this type of joint has been constantly debated in the literature. Whilst external hex connections are still hugely popular, it is now generally accepted that in contrast to claims for many implant systems with internal connections, this design concept (whether for Branemark, 3i, or any other implant system) will provide some challenge to the biologic width. This induces bone loss to the level of the first thread of the implant fixture with accompanying soft tissue recession (Figure 4).

Laterally applied stresses are

Figure 4: Tissue reaction to restored external hex implants. A cover screw over the external hex is shown on the left, the fitted crown on the right. Note that crestal bone loss occurs subsequent to the restorative phase. The final relationship between the implant and the natural tissues is somewhat similar to that of a transmucosal implant, in that the polished coronal section of the implant resides within the soft tissues of the biologic width



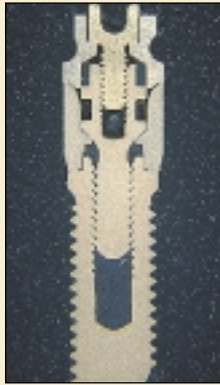


Figure 5: Cross section through an external hex assembly. The coronal screw retains the superstructure (e.g. a bonded crown). The apical screw is the abutment screw. The circumference of the abutment is seated onto the implant platform. Note the small dimension of the external hex component (the coronal extensions of the fixture itself)

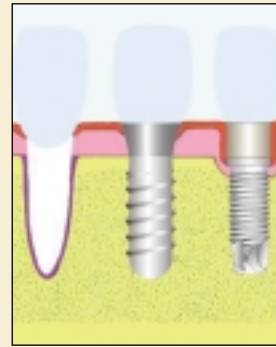


Figure 6: The biologic response to transmucosal (ITI) and external hex implants

largely transmitted to the abutment screw itself, and in the past this has caused problems with abutment screw loosening or fracture (Figure 5). Such problems have been addressed in a number of ways. Nobel Biocare's sister implants (Replace) are available with an external hex of slightly greater height (1mm). In comparison to standard Branemark and 3i external hex fixtures, these taller hex fixtures claim to give a more definite seating of abutment components, as well as reducing tipping of abutments when lateral forces are applied.

Attention has also turned to the design of the abutment screw

itself. Today, companies claim to have 'virtually eliminated' screw loosening and fatigue failure with the introduction of superior abutment screw technology. Nobel Biocare has introduced the Torque-Tight abutment screw, while 3i have the Gold-Tite screw. Both screws claim to be stronger and carry a surface coating to enhance screw performance. For example, the Gold-Tite screw carries an ultra-thin, one micron 24 Carat gold coating that acts as a dry lubricant. This is said to allow an 11° increase in screw rotation, resulting in a 75% increase in the clamping forces that the screw is able to

generate. The gold coating itself is compressed during the process of tightening the screw to 35Ncm. The palladium gold alloy nature of the screw claims superior strength and elastic properties, further enhancing clamping forces and increasing screw resistance to fracture.

From a clinical viewpoint, some practitioners follow a policy of periodically renewing abutment screws in functioning cases on external hex fixtures (perhaps every five years) to reduce the risk of inconvenient and unexpected screw-related complications.

Seating abutments onto external hex platforms (especially the standard 0.7mm high platforms) can be an awkward procedure - particularly for the inexperienced practitioner working in areas of the mouth which have restricted access. Many users report that at the chairside that it can be difficult to be sure when the abutment is properly seated. Unless the operator is experienced and confident, it is therefore generally recommended that a good quality intraoral radiograph is taken to confirm correct abutment seating before the case is restored.

INTERNAL CONNECTION DEVICES

Internal connection systems feature male abutments, with anti-rotational features milled

into the internal aspect of the female implant fixture. The abutment screw may be a separate component (Figure 5) or an integral part of the abutment itself (Figures 8 to 11).

TRANSMUCOSAL CONE CONNECTION DEVICES

ITI implants have been manufactured by Straumann for over 20 years featuring a polished transmucosal collar at heights which have been engineered to be sympathetic to the dimensions of the biologic width (Figure 6). When the standard transmucosal collar is used (with a height of 2.8mm above the crestal bone) the abutment connection will normally be just inside the mature gingival collar to give an optimum soft tissue response and to allow good access to this critical area for oral hygiene procedures. In cases where aesthetics are paramount, implants with a polished collar of only 1.8mm height are available to conceal the connection from view, yet still place the abutment connection clear of the crestal bone (Figure 7). As with external hex type implants, a number of imitations have appeared on the market over recent years. 3i now manufacture transmucosal TG implants incorporating the same vertical dimensions to the transgingival section of the fixture as the ITI design. The

Figure 7: ITI Implants. The standard implant (on the left) features a 2.8mm polished transmucosal collar. This type of implant is the preferred option in sites where aesthetics are not a high priority (e.g. lower molars, bar constructions for overdentures). The implant on the right is an 'aesthetic plus' implant incorporating a 1.8mm high polished collar. This implant is selected for use in areas where aesthetics are paramount (see the case featured in the February edition)



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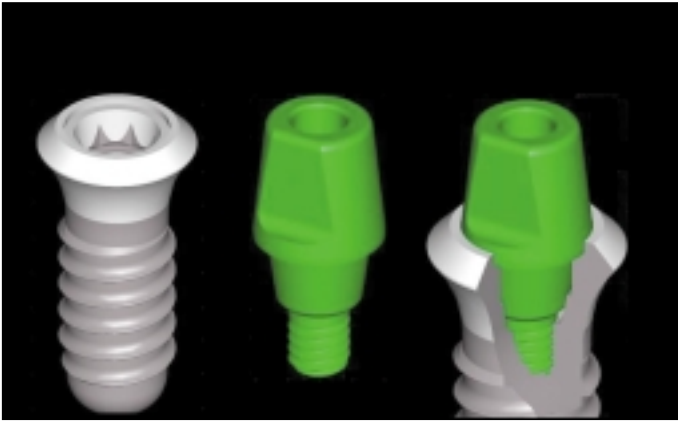


Figure 8: The ITI wideneck implant (for molar reconstructions) and a colour-coded solid titanium abutment. The union of the two is represented. Clinically, tapered conical designs give a very definite and secure union. Note the Synocta antirotational feature (for locating angled abutments) which is milled into the morse taper section

ITI and 3i systems are both manufactured with an 8° morse taper connection, giving a very definite feel when uniting the abutments with the fixtures themselves (Figure 8). When fully torqued down to 35Ncm both systems are said to achieve a ‘cold weld’ between the components with any microgap said to be below 10 microns (Figure 9). Torquing abutments onto the implant fixtures with these relatively high forces also confirms successful osseointegration (which is not yet achieved if the patient winces or the implant spins during this process!). It is helpful to have osseointegration confirmed before embarking upon costly restorative procedures.

Pre-formed angled abutments are available for both systems, but the 3i system relies on the morse taper alone to act as an anti-rotational device. The ITI system incorporates the ‘Syn-Octa’ anti-rotational feature machined into the morse taper section of the fixture, allowing more versatility during the restorative phases of treatment.

When ‘transmucosal’ type implant fixtures are employed to restore any given case, it is

sometimes argued that more accurate fixture placement is required to achieve the desired aesthetic outcome. This is because there may be less scope for subsequent correction of the vertical height of the fixture, or its axis of alignment due to the more superficial abutment connection. On the other hand, more superficial connections offer better mechanical properties to the structure as a whole.

CONE CONNECTION DEVICES - TWO-STAGE SYSTEMS

The Astra fixture range features an 11° connection taper, along with an internal star-like anti-rotational hex feature which allows the definite seating of angled abutment components (Figure 10). Cone type connections are said to achieve a cold weld between components when tightened down. The micro gap between components when the abutment is torqued down to 25Ncm is claimed to be in the order of 5 microns (Figure 11). From a biological and clinical point of view this seems to be borne out by the fact that Astra implant fixtures are designed to be seated with the head of the

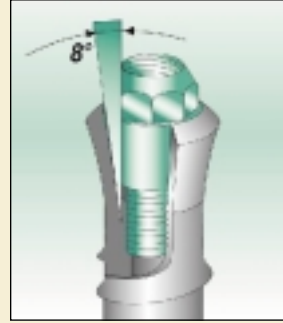


Figure 9: Schematic representation of the morse taper connection

implant at the level of the crestal bone. The subsequent process of abutment attachment to the implant fixture is not normally associated with crestal bone loss, as occurs with external hex fixtures. Compared to the external hex, seating of abutments to cone connections is easier clinically, with a more definite and solid feel when components are fully

and correctly seated.

OTHER INTERNAL DEVICES

The Frialit-2 system utilises a deep internal hex connection in conjunction with a butt joint and silicone hermetic sealing ring, while the Nobel Biocare Replace Select system has a deep internal Tri-channel connection device, again with a

Figure 10: The Astra fixture and abutment connection

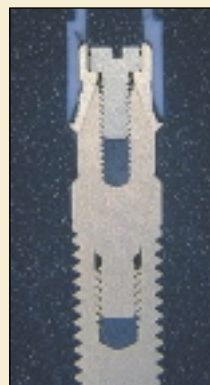
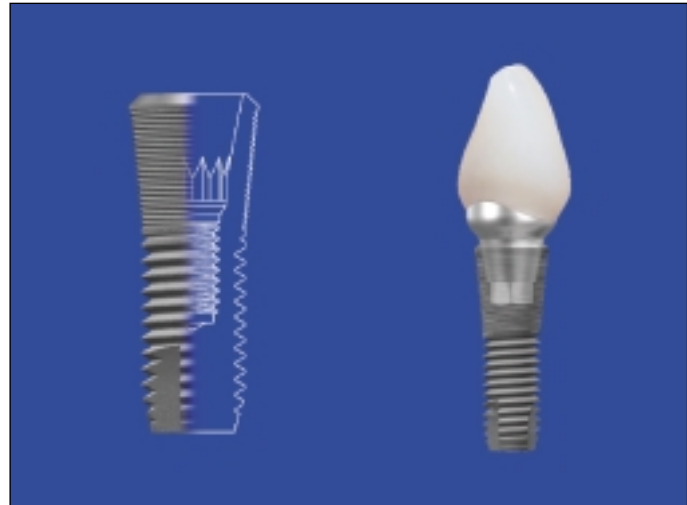


Figure 11: Cross section through a cone-fit internal abutment connection (Astra Tech). Compare this type of assembly to Figure 4

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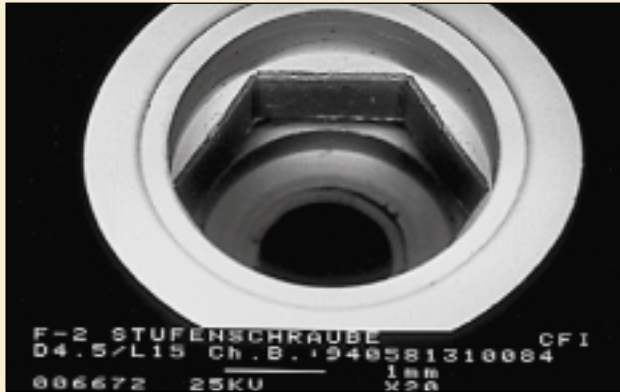


Figure 12: The deep internal hex of the Frialit-2 implant



Figure 13: The male component of the Frialit-2 connection, integral to the abutment

but-joint connection. To look at, there are many similarities between these two root-form implant systems, including a number of similarities between their respective abutment connection devices.

FRIALIT-2 - THE DEEP INTERNAL HEX

Frialit-2 uses a deep internal hex connection (Figures 12 & 13) which is almost five times deeper (3.4mm) than the height of the standard (0.7mm) external hex. This allows for a definite seating when the abutment is fitted (Figure 14). A non-ageing hermetic silicone ring is positioned in the groove of the abutment base prior to final seating the abutment (Figure 15) which is claimed to make the micro-gap between

the abutment and the fixture bacteria-proof in most instances. When the abutment screw is torqued down to 24Ncm the hermetic ring is squeezed between the sealing lip on the top of the implant and the abutment. A replacement ring is not necessary unless the abutment is removed.

During fixture insertion the surgeon needs to orientate the implant so that one of the flats of the internal hex is parallel to the buccal plate in order to optimise the choice of pre-formed angled abutments which are available at the prosthetic phase.

REPLACE SELECT - TRI-CHANNEL INTERNAL CONNECTION

The Nobel Biocare Replace



Figure 14: The Frialit-2 abutment seated

Select range feature a deep internal 'tri-channel' connection. Since this means that there is therefore a choice of only three possible orientations for angled abutments to be seated into the fixture, it becomes even more important that the surgical placement is completed with the implant in the correct rotational relationship with the buccal plate if preformed abutment components are to be selected. Alternatively, as with other fixtures, the implant could be restored using a customised Procera abutment milled in titanium. The abutment can be seated using the Nobel Biocare Torque-Tight screw, but as with all deep internal connection devices, lateral

stresses on the abutment screws are reduced in comparison with screws supporting shallow external hex connections.


Replace Select fixtures feature a 2mm polished collar (with a further 0.5mm polished section to the first thread). Interestingly, the philosophy promoted by the commercial literature on the system suggests that the operator has a choice of techniques for fixture placement. These options ranging from a fully transmucosal approach where aesthetics are not critical (achieving a 2-2.5mm polished transmucosal vertical height to the fixture), through to the other extreme of a completely endosseous placement of the fixture in aesthetically critical

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Figure 15: The Frialit-2 hemetics sealing ring is fitted over the male abutment connection prior to the definitive seating of the abutment to protect against microleakage at the connection joint

areas.

Company reps and short-term users that I have spoken with claim that crestal bone loss does not normally appear to take place with the Replace Select (internal connection) implant fixtures - even when the 2mm polished collar is placed endosseously. It is interesting to consider that whilst the philosophy of using an implant fixture with a polished endosseous coronal collar may be in line with that of some implant systems (e.g. 3i) this concept appears to be in complete opposition to the philosophies promoted by other organisations (e.g. Astra Tech / ITI). These latter companies promote the importance of a rough endosseous surface to the full height of the crestal bone as a prerequisite to stable crestal bone levels. See the second part of this series for more details on these design concepts (Allum, 2002). 

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