As we are continuously bombarded in our professional media with the benefits of one dental implant system over another, it can be difficult for those of us who have not yet chosen a system to make an objective choice based on true clinical and research-based findings.

For those of us who already have chosen to go with one system or another, we sometimes find ourselves questioning whether or not we should be looking at switching, or if the system we use still serves its purpose adequately. Should we all be using different systems for different applications? Is there any one system that serves all purposes?

Starting our search
In terms of what parameters to look at when selecting or evaluating a system, this can be broadly outlined into the following aspects:

1. Implant material
   a) Commercially pure titanium vs. titanium alloy
   b) Surface treatment and additions to the surface

2. Implant design
   a) Body shape
   b) Abutment connection
   c) Shoulder design
   d) Threads and microthreads
   e) Connective tissue connection
   f) Widths and lengths
   g) Conical seal

3. Prosthetic choice
   a) Choice of abutment systems
   b) Technician’s advice

4. Ease of use

5. Long term studies specific to the system

6. Cost

7. Support

Implant materials
The majority of implant systems in the dental world are either made of commercially pure titanium or an alloy of titanium, aluminium and vanadium. Titanium alloy is less costly and has four times the fracture resistance of commercially pure titanium. On the other hand, long-term studies suggest that the bone-to-implant contact and long-term stability of titanium alloy is inferior to that of commercially pure titanium.

Osseointegration is not only a property of pure titanium, but also of the titanium oxide ceramic coating that forms on the surface of titanium. Titanium alloys containing aluminium and vanadium have been found to cause ionic activity from the aluminium, which can affect the long-term stability of the osseointegration.

Surfaces of implants started off as simply machined and then surface roughening later followed as one of the major advances, increasing bone-to-implant contact by increasing the available surface area, but more importantly, by somehow simulating the roughness of bone.

Roughening actually increases the speed and degree of osseointegration by stimulating various local factors (i.e., PGE, TGF). It has been found that a specific range of roughness (Ra 3-7 microns, also referred to as ‘medium rough’) increases the rate of production of these factors and thus the degree and rate of osseointegration as well as the response of osteoblasts to systemic hormones.

On the other hand, surface roughness is not without its drawbacks. If the rough surface becomes exposed, biofilm formation can be more problematic which can lead to various degrees of peri-implant problems. Different studies have proposed different ways of dealing with this including treatment of the surface with various antimicro-
Various products have been applied to implant surfaces to increase the rate and stability of osseointegration including calcium phosphate in various forms (hydroxyapatite, tricalcium phosphate) and fluoride, and various biological agents such as PRP and BMPs. Hydroxyapatite has been found to initially stimulate formation but to later separate in part from the implant surface and thus reduce the overall long-term stability, as it forms a low-strength interface between the bone and the implant surface. Fluoride treatment is claimed to increase the speed of osseointegration, which increases the ability to immediately load the implant, but does not affect the long-term degree of BIC (bone-to-implant contact) or resistance to bone loss. Other systems that use other methods make similar claims.

**Sterilisation and packaging**

The way in which the implant is sterilised and stored also has some effect on the rate and degree of osseointegration. Wettability of an implant surface, a characteristic related to its surface energy, affects the rate of adsorption of tissue proteins that comprise the initial phase of cellular adhesion (and hence the quality of osseointegration). Discussion of this is beyond the scope of this article, but it is wise to enquire into the treatment and packaging of the implant system being investigated.

**The implant design**

Root form dental implants available in the market all tend nowadays to follow a similar shape and form. It is now commonplace to find implants with either a straight or tapered body, threads at various distances along the body and ‘micro-threading’ at the coronal aspect of the implant. Microthreaded implants were found to maintain bone levels more securely at the coronal aspect, it is claimed, by wider distribution of stresses. Body shape appears to be a matter of choice. Generally they are either parallel-sided or tapered (whether or not there is an additional coronal flare). Tapered implants would seem ‘safer’ implants in tight gaps or where roots of neighbouring teeth converge. There do not seem to be any other advantages with regard to stress distribution or general strength of the implant.

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**Treatment of the polished part of the collar or shoulder in one system by laser etching has found the potential attachment of**
connective tissue fibres, not only parallel to and circumferentially around the implant/abutment but also perpendicularly with the laser etched surface, interlocking with the uniquely etched laser-locks. This is claimed to increase the integrity of the soft tissue junction with the implant and thus to protect the bone levels achieved. It will need to be substantiated whether or not this connective tissue locking does in fact protect the bone level compared to an implant with a polished bevel or collar (or neither) and by how much.

Self-tapping implants (when the implant cuts its own channel into the bone as it is driven in) are claimed to increase primary stability by engaging with the bone chips produced as they cut through. When compared with pre-tapped implant systems (where a ‘bone-tag’ is first used to create the channels), the difference is not significant.

A range of sizes
Most implant systems have a range of widths and lengths. General wisdom and most studies will show that anything equal to or above four mm width is very fracture resistant. Implants less than four mm in width (often required in tighter spaces or thinner ridges), were at first approached with caution, partly because of the reduced sturdiness of their connecting components. However, 3.5mm and 3.75mm implants are now in common usage and have shown good clinical results.

Wider implants are useful by giving better emergence profiles for posterior units and by increasing surface area especially in low height situations, but should be placed with thought for crestal bone preservation. Less than one mm of surrounding bone at the implant shoulder can lead to its resorption.

Short implants are still the subject of some debate which will be covered in a future article.

External hex vs internal connections
Interestingly, a number of prominent implantologists continue to use implants that feature an external hex connection. This type of connection tends to concentrate occlusal forces at the neck of the implant and can potentially cause bone loss at this coronal aspect. The various internal connections, particularly the internal cone connection has been found to help distribute forces along the coronal aspect of the implant (Figure 3). Internal cones (whether with or without screws) also tend to be more stable against lateral forces and to significantly decrease the width of the ‘microgap’ that has been the subject of many studies.

This microgap, often found in ‘flat-top’ external hex connections, its dimension being on average about 50 microns, tends to harbour a biofilm, the inflammatory reaction of which has been suspected to cause bone to resorb away from it. Once a certain amount of resorption occurs, the bone can then remain stable. The elimination of the microgap seems to be the logical approach though.

To eliminate the microgap, implant manufacturers developed the ‘conical seal’. This internal cone connection (which can be screw retained or tapped in, indexed or non-indexed), gives rise to a longer implant-abutment connection which virtually cold-welds. The microgap is almost totally eliminated. Both research and clinical evidence show much lower rates of biofilm formation. Clinically, this is most often noticed by the lack of an offensive odour, when the abutment is detached.

Bone-level vs tissue level
Generally, the ability to place implants at bone level (Figure 4) and to leave them submerged while maintaining the bone at the level of the implant shoulder would seem to be an advantage. It was postulated by manufacturers who produced exclusively tissue level implants (for example, implants that have polished collars and are placed in a non-submerged technique), that bone level implants would potentially lose bone due to the repeated connection and disconnection of the abutments.

Certainly, this was found to have some effect on bone stability, and it is advised that once an abutment is finally connected, that this is no longer removed. On the other hand, even the stalwarts of the tissue level implant have now produced bone level implants, to increase ‘flexibility’. Undoubtedly, a bone level
implant gives one the chance to increase or decrease the emergence profile as required and to adjust the angulation of the abutment as required without risking show of metal.

**Abutment choice**

Any implant system of worth should be able to provide the operator with a range of abutment options. It is, in my opinion, vital that screw-retained prostheses be possible with the system and that cement retention is not the only option. Screw retention (Figure 5) is when the abutment and crown (or bridge unit) are one unit, screwed directly down onto the implant. The primary advantage of this is serviceability. For those of us who have been providing implants for long enough (and most studies will also show), it is more likely to be a defect of the prosthesis (or superstructure) that requires correction after seven to eight years of service and not the implant fixture.

This requires, in the case of cement-retained prostheses, a fairly tricky removal of the crown or bridge without damaging the abutment or the implants. With screw retention, all that is required is a quick removal with a screwdriver. Certainly this is not possible in all cases, especially angled implants in the aesthetic zone, but restoring most posterior units this way has its merit. This entails the implant manufacturer providing some form of castable abutment (often referred to as ‘UCLA-type’) for single unit and multiple unit cases. It is very difficult in my opinion to get away with having only ready-made angled abutments. (Figure 6)

Another important feature is indexing. This is when the abutment has an anti-rotational feature, which is very useful in single tooth cases. This can be by any number of sides internally as long as it ensures the abutment will not rotate. The greater the number of sides, the greater the positional flexibility in terms of implant placement as you won’t have to rotate the implant to a specific rotational position.

Some systems also give the option of CAD-CAM abutments, which are useful as these can be made to exact requirements in the material of choice.

Zirconia abutments are a good option to have available as these can get one out of a bad situation in the aesthetic zone. Abutment fracture of ceramic abutments has been documented, so they are used with caution. More research and numbers are needed. (Figure 7)

**A technician’s opinion**

It’s always a good idea, when choosing an implant system, to check with your technician what he/she finds easy to use and what they think provides the best results. Technical flexibility is absolutely vital as we can’t always provide our implants at the exact required angle and position. Sometimes, for clinical reasons, it’s actually a good idea to angle an implant and sometimes it is inevitable. Occasionally we make the mistake of not judging soft tissue thickness or bone response or even the outcome of carefully planned GBR.

In all these cases, having flexible and precise prosthetic systems can often save the day. This is of course, no excuse for bad implant placement and all care should be taken prior to embarking on a case to ensure that all the necessary information has been gathered and prosthetic-driven planning performed. Working with an experienced technician who has used more than one system is vital to the success of your implant practice.

**Ease of use**

From a surgical viewpoint, it’s always nice to have a system that’s straightforward. Fewer steps to place an implant, making placement faster and simpler would be good for both operator and patient. On the other hand, it makes sense to have a system that covers all possibilities.

Certain situations require a degree of flexibility and a greater variety of implant drills. For example you may wish to under-prepare an osteotomy because the cancellous bone is soft. In the same osteotomy, you might need to prepare the cortical bone to the standard drilling...