In 2010, Dr Pär Johansson received his dentistry degree at Malmö University in Sweden, where he submitted a master thesis on implant surfaces. A few years later, he joined a research team at the same department as they were launching an interesting project on a new implantable material, PEEK (polyetheretherketone). In an interview with today international, Johansson spoke about the advantages and challenges of PEEK implants and what the new material could mean for the future of implantology.

**today international: What, in your opinion, has been the greatest development in dental implantology throughout the decades?**

**Dr Pär Johansson:** Since the discovery of osseointegration, the development of dental implantology has been extraordinary and extremely fast. The advancement began by experimenting with different implant materials and inventive shapes and forms. Thereafter, the implant surface was modified using several subtractive and additive methods to shorten the healing time and increase the success rate. Today, researchers are attempting to improve osseointegration by loading the implant surface with pharmaceuticals or proteins. As a researcher, I would say that the most important developments in dental implantology have been the surface improvements and, to some extent, our understanding of bone and implant interaction. As a clinician, the greatest developments have been improved treatment protocols and the implementation of digital appliances.

**At the 2017 European Association for Osseointegration (EAO) congress, you will be giving a lecture about PEEK implants. What was your motivation behind specialising in this implant material?**

**The project became my PhD project, which I am defending later this year.** PEEK is a highly advanced polymer with properties that could improve the treatment outcomes of several procedures. The challenge is that PEEK is not optimal as a loadbearing implant because of its low density. Therefore, researchers have attempted to improve osseointegration by loading the implant surface with pharmaceuticals or proteins. As a researcher, I would say that the most important developments in dental implantology have been the surface improvements and, to some extent, our understanding of bone and implant interaction. As a clinician, the greatest developments have been improved treatment protocols and the implementation of digital appliances.

**PEEK is not optimal as a loadbearing implant.**

It has been argued that implantable PEEK polymers are a next-generation biomaterial. Is that fact or fantasy?

I would say that PEEK has come a long way to becoming the next-generation biomaterial in the orthopaedic field. Today, PEEK is the standard implant material in several spinal procedures and ongoing research has introduced more applications. In dentistry, the introduction of PEEK has been slow, but the material may well be functional in healing abutments, temporary cylinders and dental frameworks. Introduction of new biomaterials is a slow process which requires a comprehensive evaluation by the U.S. Food and Drug Administration before it can be implemented for clinical trials. PEEK-OPTIMA (Invibio) is currently the only commercial PEEK polymer approved by the FDA as a medical device.

**What are the main advantages of PEEK in comparison with conventional implant materials like titanium? What are its limitations?**

The main advantage in spine and trauma surgery is its superior biomechanical properties compared with metals. PEEK has an elastic modulus similar to that of human bone, while that of titanium is almost eightfold higher. Differences in elastic modulus between the implant and the surrounding tissue may promote stress shielding and inhibit bone growth or lead to bone resorption. Furthermore, titanium and metal alloys have, in some documented cases, caused signs of hypersensitivity and allergy. Three days, there is also an increasing demand for non-metallic restorations and biomaterials. PEEK has a low density, has a non-reactive surface and, according to current literature, has never shown any signs of provoking hypersensitivity. The colour of PEEK is more natural, and this enables the manufacturing of aesthetic implants for thin biotypes and diverse dental components. Finally, PEEK is transparent to X-rays, which is a feature highly useful after spine surgery, allowing the postoperative radiographs to be viewed and analysed without any disturbing artefacts.

**The results of a study in rabbit bone you conducted in 2016 proved that the addition of a nanosized hydroxyapatite-coating to PEEK surfaces improved the bone-implant contact and demonstrated strong osteoconductive properties at the perforation. How important are these findings to advancing research on PEEK implants?**

This aforementioned study is the third by our research group on PEEK. There were two main areas of investigation regarding the material used in this study, the use of PEEK as a biomaterial and the innovative coating technique by which a nanosized hydroxyapatite coating is applied to the implant surface.

Further, this study showed the osteointegration potential of PEEK in rabbit bone. This is important for advancing research on PEEK implants.

**PEEK is not optimal as a loadbearing implant.**
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evaluated a PEEK implant with a unique design: the implant is manufactured with an apical perforation to enable evaluation of the bone fusion. The design is mainly aimed to be correlated to spinal applications where PEEK implants are currently used as cages between the vertebrae to facilitate bone fusion. The results of this study show the significant effect of surface modification using nano-hydroxyapatite. These outcomes are important in inspiring and facilitating future research on PEEK and nano-hydroxyapatite. This coating technique can further be applied to PEEK implants with other design and surface properties of the core material.

Do PEEK implants have a good success rate in human patient cases that would allow them to be used in all clinical situations?

PEEK implants used in spinal surgery have in retrospective studies showed equal or more successful outcomes in terms of treatment success and bone formation compared with titanium. Recently, the FDA has given clearance for hydroxyapatite-coated and -impregnated PEEK implants. However, the approval only applies to PEEK as an inter-body spine implant. It is difficult to relate the outcomes as a spine implant to other applications, since the design, loading and surrounding tissue are different. However, if hydroxyapatite-modified PEEK can reach comparable levels of osseointegration to titanium, there will be a manifold increase in applications.

How likely do you think it is that PEEK dental implants will replace conventional ones in the near future?

Replacing titanium in oral implantology will require more research including experimental studies and clinical trials. According to the current literature on PEEK and its various bioactive improvements, the level of osseointegration does not seem sufficient to withstand the load from masticatory forces. However, an introduction into the dental field could be as an orthodontic implant implanted for a relatively short period of function and with less and more controlled applied force.

Dr Pär Johansson will be presenting his lecture titled “PEEK implants. Ready for clinical use?” at EAO Madrid 2017 on 7 October in Arena 5.
About 15 years ago, some of the implant companies began to change their focus. While previously it was all about proving that the respective implant system did function, a new era began once it had been established that implants do really work. In this era, the emphasis became selling more implants.

My first big international presentation was at the EAO conference in Paris in France in 2004. I remember that I was excited and well prepared. I thought I killed it, as people loved it. It felt great. However, fellow lecturers and representatives of the industry suggested that I should change the topic. But change to what? I was told that regeneration was over. Flapless surgery had arrived and there was no longer any need to use bone grafts and membranes, especially non-resorbable ones. They asked me to use this and that new implant with a new design and maybe brand-new surface and just put it in without a flap. They said they would invite me to be their speaker. I thought, well, I would not be a speaker then. My patients needed bone despite the trend.

I love to take care of my patients and will keep doing what is best for them by choosing implants that I think are best for a particular case and not what the industry tells me to use. Years have passed and I became deeply involved with regeneration. I loved it and did not care how the flapless business was doing until there was no way to avoid the results arising from it. We encountered problems. Lost implants, peri-implant disease and bone loss around implants became a public health issue. I started to see more and more patients who needed regeneration of defects created by failed implant treatments.

In the meantime, I studied and developed evidence-based research on vertical and horizontal ridge augmentation. This resulted in the Sausage Technique, which is now widely recognised and used. I enjoy teaching and it feels great to see peers using my techniques successfully. It is fascinating to see how many patients around the globe are helped by using these techniques.

Regeneration is now less invasive and more predictable. As an enthusiast, I love regeneration so much that I would never want to do anything else. I really think it has a bright future. I recommend to all my colleagues to find a field of this exciting profession that they can be passionate about. We should keep acting in consideration of the best interests of our patients.

Regeneration is needed more than ever

By EAO 2017 presenter Dr István Urbán, Hungary

Dr István Urbán maintains a private practice in Budapest in Hungary. This afternoon, he is presenting a paper titled “Use of bone substitutes and barrier devices” in Room Madrid as part of this year’s EAO congress programme.
Digitising your implant practice

By Dr Ross Cutts, UK

Undoubtedly, digital dentistry is the current topic. Over the last five years, the entire digital workflow has progressed in leaps and bounds. There are so many different digital applications that it is sometimes difficult to keep up with all the advances. Many dentists are excited about the advantages of new technologies, but there are an equal number who doubt that the improved clinical workflow justifies the expense.

I have many times heard the argument that there is no need to fix something that is not broken. It is so true that impressions have their place and there are certainly limitations to the digital workflow that anyone using the technology should be aware of. For me, however, the benefits of digital far outweigh the disadvantages. In fact, the disadvantages are the same as with conventional techniques.

Chairside CAD/CAM single-visit restorations have been possible for over 20 years, but it was only recently that we became able to mill crown restorations with conventional techniques. With laboratories as early adopters, substituting the lost-wax technique and the expense of gold and zirconia customised abutments (Fig. 1). This has led to a massive rise in the incidence of peri-implantitis and have seen a massive rise in the incidence of perimplantitis and have found that a large proportion of these cases can be attributed to cement inclusion if the restoration is not carefully fitted (Fig. 3).

In the survey, 89 per cent also said they believed CAD/CAM technology had a major role to play in the future of dentistry. I really cannot imagine that once a dentist has begun using digital processes that he or she would revert to conventional techniques.

What is digital implant dentistry?

Many implant clinicians have probably been using CAD/CAM workflows without even realising it, as many laboratories were early adopters. The digital scan image comes up in real time and you can evaluate your preparation and quality of the scan on the screen immediately. Seeing the preparation blown up in size no doubt improves the technical quality of your tooth preparations. The scan then be sent directly to the laboratory for processing.

While we do not think of intraoral scanners as being any more accurate than good-quality conventional impressions, there are many benefits of scanning, such as no more postage to be paid for impressions, vastly reduced cost of impression materials, almost zero re-impression rates and absolute predictability.

Of course, there are steep learning curves with the techniques, but once a clinician has learnt the workflow, there really is no looking back.

We have three different scanners in the practice: the Tera (Align Technology), the CEREC Omnicam (Dentsply Sirona) and the Straumann CARES Intraoral Scanner (Dental Wings; Fig. 14). The CEREC Omnicam is fantastic for simple chairside CAD/CAM restorations, such as IPS e.max all-ceramic...
restorations on Variobase abutments. For truly aesthetic results, we, of course, still have a very close working relationship with our laboratory, but, undoubtedly, patients love the option of restoration in a day. Being able to scan an implant abutment and then an hour later (to allow for staining and glazing) fitting the definitive restoration is a game changer. Patients also love watching the production process as they see their tooth being milled from an IPS e.max block.

Figures 15 to 19 show the production process, including the exposure of the implant, the abutment seating, the scan flag on top of the abutment, the healing abutment during fabrication and the delivery of the final prosthesis. However, for more than single units or aesthetic single-unit cases, we use the iTero and Straumann scanners. The latter we have only had at our disposal since February. While it is a powered system at the moment, this is due to change this month. Particularly with implant restorations, the need to apply a scanning powder is a limitation, owing to a lack of moisture control contaminating the powder. The technology, however, is superb, as is the openness of the system, which provides the advantage of being able to export files into planning software. A colleague of mine even uses it for his orthodontic cases now instead of wet impressions.

We invested in the iTero scanner five years ago and have used it for everything, from simple conventional crowns and bridges to scanning for full-mouth rehabilitations. When fabricating definitive bridge work, we use Createch Medical frameworks for screw-retained CAD/CAM-milled titanium and cobalt-chromium frameworks. Even though intracoronal scanning appears extremely reproducible and accurate, I still use verification jigs where needed to ensure our frameworks are as accurate as possible. There are many intricacies that we consider and tips and techniques that we employ to make the scans more accurate that we have developed over time. The closer the scanbodies are together, the more accurate the scan is. Also, the more anatomical detail, such as palatal rugae or mucosal folds, the better the scans can be stitched together.

Figure 20 shows a CBCT volume to aid in planning for mandibular implant placement and realising the implant placement (Fig. 21). We exposed the fixtures and placed Straumann Mono Scanbodies (Fig. 22). Then, we took an iTero scan of the fixtures in situ (Fig. 23) and made a verification jig from this (Fig. 24) to ensure passive implant positioning. The iTero models were made (Fig. 25) and a Createch titanium framework was used to support porcelain in a screw-retained design (Fig. 26). The last two figures show the excellent outcome and accurate framework seating (Figs. 27 and 28).

Choosing your workflow

There are many different systems on the market now, each offering a one-stop shop. If you are considering investing in a digital scanner, then take some advice from colleagues. One of the most important things is to ensure the system you opt for is an open one that allows you to extract the digital impression data into different software. We extract our files into CT planning software, model production software, chairside milling software, and now orthodontic planning software. I am convinced there will be yet more advances with time. The size of the camera is critical—some can be very cumbersome—and it is worth asking the salesperson what developments are underway.

Some companies are more on the cutting edge than others. My favourite at the moment is the Straumann scanner. Its design is light and user-friendly and it synchronises perfectly with coDiagnostiX implant planning software. Furthermore, while it offers a chairside milling unit, it also synchronises perfectly with my laboratory for larger cases.

To conclude, digital implant dentistry is the future and so why not take advantage of it and help improve your clinical outcomes? 

Dr Ross Cutts is the principal dentist at Cirencester Dental Practice in Cirencester in the UK. He can be contacted at cuttsrg@aol.com.
For the first time ever, a robot has independently placed two 3-D-printed implants into a patient’s mouth without human involvement. The successful procedure raises hopes of lessening Asia’s dentist shortage, especially prevalent in metropolises such as Hong Kong and Singapore, and of avoiding risks posed by poor-quality surgeries performed by unqualified dentists.

After taking a CT scan to acquire data on the female patient’s skull and jaw, the medical staff fitted position orientation equipment to the woman and determined the movements, angle and depth needed to fit the implants in her mouth so that the robot could be programmed to move into the correct position to carry out the operation. According to Prof. Zhao Yimin, a surgeon from the Fourth Military Medical University (FMMU) in Xi’an, the procedure went very smoothly and the implants were placed with high precision.

Although human staff were present at all times during the 1-hour surgery, they did not play an active role. The robot, which was jointly developed by the Beihang University in Beijing in China and FMMU’s Stomatological Hospital over the last four years, is designed to follow a set of preprogrammed commands, but is able to make adjustments during surgery, the South China Morning Post reported.

According to a recent survey, about 400 million patients are in need of dental implants in China. However, the number of qualified dentists in the country is insufficient to meet the increasing demand. Through a continuing implementation of robot technology, this shortage may be eased.

In the future, robot-assisted and -led technology could increasingly facilitate dental surgeons’ work, experts have predicted. Robotic technology has already been introduced in recent years to assist in dental procedures such as root canal therapy, orthodontic operations and implant placement. In March this year, a pioneering robotic guidance system, Yomi, received clearance from the U.S. Food and Drug Administration. The computerised navigational system delivers physical guidance through the use of haptic robotic technology, which provides sensory feedback and constrains the drill in position, orientation and depth, the device’s manufacturer, Neos, stated.
The role of prevention in implantology

By Dr Peter van der Schoor, The Netherlands

In October last year, I had the honour of speaking in front of a medical and dental audience to explain my approach to prevention. In my lecture, I talked about our new “perio profiling” approach using saliva and aMMP-8 diagnostic methods. The thing is, we need to treat patients between the ages of 20 and 40 differently to those who are 40 years and older. Certainly, everyone can get periodontitis, but my younger patients visit my dental practice less frequently, which means they are at a higher risk of developing periodontal diseases. Interestingly, we have always had difficulty achieving the necessary compliance from patients in this younger age group to obtain good dental hygiene in order to prevent periodontitis.

Also, we have found that well-known diagnostic methods, such as PSI or BOF, do not necessarily “lock ahead”, nor are they predictive—which is exactly what we need to make sure we are not always too late with our treatment. Now, finally, we have found a way to do this.

The well-documented collagen destruction indicator, aMMP-8 can be measured in the saliva (with PerioSafe) and is, for us, the new gold standard for predictive analysis in preventive dentistry. It helps us identify the patients with the greatest need for preventive treatment and at the right point in time, which is when the sub-clinical collagen destruction of periodontal tissue has started, but it is not yet visible.

Fortunately, the Dutch public health insurance system has recognised the “predictive value” and solid scientific data of aMMP-8 diagnostic methods and is going to fully reimburse the cost of the diagnostic treatment for every patient by 2018. This decision is a breakthrough for targeted healthcare in dentistry.

A proven concept

At my practice, we ran a study with over 200 periodontally-healthy patients, between the ages of 20 and 40 years. Each patient received a free PerioSafe test. Interestingly, 40 per cent of these participants tested positive for the presence of aMMP-8. All of these patients wanted to stay at our practice for oral hygiene treatment. Of the other 60 per cent who had a negative result, around ten per cent still asked for an oral hygiene treatment. This means that only one test is necessary to triple the number of dental hygiene procedures for 40 per cent of the patients in your practice.

I have done over 30,000 implants in my life and about ten per cent of those have failed. The overwhelming majority of failures were due to patients developing peri-implantitis. For patients who would like to have implants, we first have to determine what has gone wrong with their natural dentition. Which is why, prior to implant placement, we use the PerioSafe test to evaluate whether there is silent inflammation that might need attention. After the implant surgery, we use the Implant Safe test for regular monitoring to prevent peri-implantitis. The patient has to test negative for aMMP-8 to guarantee tissue stability and since our strategy is sustainability, aMMP-8 is the most effective diagnostic tool available to date.

Looking forward, we now have to step into the world of digital saliva diagnostics that is performed as a chairside, aMMP-8 quantification with the ORALyzer, which is one of the biggest inventions in dentistry, because it allows us to precisely look at the patient’s immune response system and print out an analysis report within a couple of seconds. This tool is exactly what we need to fight peri-implantitis and periodontitis. With the ORALyzer can even measure the success of our treatment by seeing a reduction of aMMP-8 concentration in the saliva, measured in ng/ml.

Some dentists think they cannot earn money with prevention, but I want every dentist to understand that 40–50 per cent of all patients will need two to four dental hygiene procedures per year to prevent deterioration. aMMP-8 saliva diagnostics open the door to much needed “patient targeting” and “compliance” and there is nothing else available that can compare to it at this point in time. It is a prevention-needed indicator and a patient motivator. Simply do the calculation for yourself, it is a win-win for the dentist and the patient.

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