The effect of different wax pattern construction techniques on the customized lit...

Implant therapy is expanding and becoming more popular and convenient treatment option. The procedure itself became easier with better outcomes. Many systems are available in the market; having knowledge with these systems is the key for approaching cases more precisely. Technology on the other hand enhanced the prosthetic outcome of implant therapy. This will all lead to better quality of life for the patients.

Custom abutments are one of these advances, it main advantage is that its individual-specific soft tissue management which was very difficult to achieve with the prefabricated abutments.

Still many clinicians use the prefabricated abutment, because it was successful for years. The introduction of the tooth colored restorations and the extreme benefit of the titanium to titanium connection for implants helped in the development and need for custom abutments with ideal emergence profile. A Little research was done to measure the custom made abutment from many perspectives such as fitness, retention, accuracy, esthetics, cost and much more.

With the increased demand for more esthetics, all-ceramic restorations became very popular over the last decades. Such restorative all-ceramic systems should fulfill biomechanical requirements, longevity similar to metal — ceramic restorations while providing enhanced esthetics. This is extremely important for implant prosthetics. Implant abutment fabrication techniques:

Prefabricated versus customized abutments: Implant abutments are supplied either in a prefabricated form (straight or angulated) and could be modified by the lab or the dentist; or customized through wax up. Recently digitally designed and milled using CAD/CAM or 3D printed. The main drawback of prefabricated abutments is that they cannot provide an ideal emergence profile, lacking enough support to labial and proximal perimplant soft tissue. There is a difference between the implant cross section and the natural tooth. The transition between the circular cross section of the implant should be done either by the crown or the abutment. Performing this with the crown will require the crown margin to end deeply submucosal, while performing this with the abutment will require a customized abutment. The customized abutments can be performed with the digital technology which allows to perfectly mimic the adjacent teeth contour and controlling the abutment finish line to decrease the risk of leaving excess cement especially if using tooth colored material and above all digital dentistry is less time consuming and decrease the finishing procedure time.

Custom made hybrid abutment

Hybrid abutments were introduced to gain the benefit of the titanium abutments together with the all ceramic abutments. It has the benefit of the titanium to titanium connection and the esthetics of the all ceramic custom abutments. The customized tooth colored abutment is cemented to the titanium insert extra orally.

Lithium disilicate hybrid abutments

IPS e. max lithium disilicate was introduced in 2005, as an improved hot-pressed ceramic material, in order to expand the range of indications of the previously used IPS Empress 2. This lithium disilicate is a glass ceramic that is composed of quartz, lithium dioxide, phosphor oxide, alumina, potassium oxide and other components. The properties include high flexural strength

(360 MPa to 440 MPa), high fracture toughness (2-3 MPa) and high thermal shock resistance due to the low thermal expansion (7). Lithium disilicate abutments could be fabricated either with heat pressing or with CAD/CAM technology. There is a variation in strength, surface quality, margin integrity, less wear of the opposing and level of details between the processing techniques.(8)Sui etal 2014 (9); described the technique of fabricating a pressed lithium disilicate on a titanium abutment and then restoring with a lithium disilicate crown. Its provided the esthetics of the lithium disilicate , titanium to titanium connection and supra gingival finish line however it needed more space due to multiple layers.

The lithium disilicate abutment could be produced either with pressing or milling. For the pressing technique, the wax pattern could be produced by conventional method or CAD/CAM wax milling or by 3D printing.

Techniques of fabrication of wax pattern for pressing

Conventionally wax pattern was fabricated with manual tools such as PKT instruments. Wax is easily shaped and easily eliminated with heat, however it has a several disadvantages such as delicacy, thermal sensitivity, high coefficient of thermal expansion, require a skilled technician and time consuming, thus the CAD/CAM system was introduced. In dental literature little research was done about additive manufacturing accuracy. For selective laser melting the accuracy of metal work prosthesis was acceptable for intraoral prosthesis. Regarding the wax pattern construction, if we look today then CAD/CAM in dentistry is based around the process of subtractive manufacturing. The technology most people will be familiar with is computer numerically controlled machining, which is the processes in which powerdriven tools, such as saws, lathes, milling machines, and drill presses, are used with a sharp cutting tool to mechanically cut the material to achieve the desired geometry when all the steps are controlled by a computer program. It has been stated that by using this method the overall production time will reduce considerably and complex models, which are otherwise difficult and/or impossible to make by the conventional dental processes could be built rather easily.

Additive manufacturing on the other hand is defined by the American Society for Testing and Materials (ASTM) as: The process of joining materials to make objects from a 3D model data, usually layer by layer, as opposed to subtractive manufacturing method. In principle the process works by taking a 3D computer file and creating a series of cross-sectional slices. Each slice is then printed one on top of the other to create the 3D object. One attractive feature of this process is that there is no waste material. Traditionally additive manufacturing processes started to be used in the 1980s to manufacture prototypes, models and casting patterns. Thus it has its origins in rapid prototyping (RP), which is the name given to the rapid production of models using additive layer manufacturing. Today additive manufacturing describes technologies that can be used anywhere throughout the product life cycle from pre-production (i. e. rapid prototyping) to full scale production (also known as rapid manufacturing) and even for tooling applications or post production customization. Alongside these developments the type of the materials that the industry uses has increased greatly and modern machines can print a broad array of polymers, metals and ceramics. As the industry makes the transition from prototypes to functional devices the materials available will begin to play a bigger role. When producing a prototype it is enough for it to look good, but for functional objects such as customized implants and oral prostheses the materials and their properties become much more important.

Marginal accuracy

Long term success of ceramic restoration is dependent on the marginal accuracy. Micro leakage may result in periodontal tissue inflammation and failure of the prosthesis. In the literature several techniques have been suggested for the measurement of the marginal fit alone or in combination with the internal fit of crowns. All of these present advantages and disadvantages, and a small description of the most commonly used ones will follow.

A technique used in vitro is the classic destructive method of sectioning the specimens and then studying them under an optical or scanning electron microscope. The advantage of this technique is the accuracy and the precision in repeatability of the measurements; however the obvious limitations of this method are the destruction of the specimens which creates the need for duplicates, the limited area that is evaluated since the sections have a minimum thickness and the additional steps that are required (embedding in resin and sectioning).

Tan et al in 2008, used a similar setting (and therefore similar technique limitation) in order to compare the marginal adaptation of CAD/CAM, wax/CAM and wax/cast restorations. They took a 1: 1 photograph of each of four sides of the die using a digital camera mounted on a tripod. All photographs were taken sequentially with no change in the horizontal inclination of the camera. Calibrated digital measurement software was used to measure the marginal openings.

Romeo et al in 2009(19) , used a stereomicroscope under 50x magnification to measure the marginal adaptation of CAD/CAM restorations (Photographs were taken under the microscope and the measurements were performed with PC software. Despite the non- destructive nature of the method, which is very favorable, it is very technique-sensitive; a slight deviation of the photographic angle will distort the measurement. Specifically, because the microscope is set perpendicular to the margin of the restoration, it makes it impossible to evaluate the marginal gap of an overhanging restoration (vertical over- extension); thus, a 0µm value would not necessarily mean that the restoration has a perfect fit.

In summary, the measuring techniques used for marginal and internal fit of crowns were categorized by Sorensen (1990) as follows: 1) Direct view, 2) Cross- sectional, 3) Impression technique, and 4) Explorer and visual examination. However, with the advancement of the technology, new categories will be added. By digitizing the specimens (dies, silicon films or even the intaglio of the crown itself), the data sets acquired allow for several measurements and comparisons.

Giannetopoulos et al in 2010, studied the marginal integrity of ceramic copings with different marginal angles using two different CAD/CAM systems. Three brass models were prepared with a different marginal finish line, namely a 08 bevel (or 90 shoulder), a 30 bevel and a 60 bevel. Ten restorations were produced for each finishing line and CAD/CAM system, respectively. The copings were milled from lithium disilicate glass ceramic blocks (IPS e. max1 CAD). An impression was taken for each model to fabricate a series of 10 replica dies for each marginal design. The average Chipping Factor (CF) of the CEREC copings was: 2. 8% for the 0 bevel angle, 3. 5% for the 30 bevel angle and 10% for the 60 bevel angle. For the EVEREST copings the average CF was: 0. 6% for the 0 bevel angle, 3. 2% for the 30 bevel angle and 2. 0% for the 60 bevel angle. Quantitative analysis of the margins of each coping was performed using digital photography and image analysis software. The marginal integrity of the restorations was evaluated by detecting and measuring any signs of marginal chipping and the Chipping Factor (CF) was calculated.

Oliver Schaefer et al in 2011(22) studied the Marginal and internal fit of pressed lithium disilicate partial crowns, An acrylic model of a lower left first molar was prepared to receive a partial crown and duplicated by single step dual viscosity impressions. Corresponding working casts were formed from Type IV die stone and indirect restorations were fabricated from heat-pressable lithium disilicate ceramics. The acrylic tooth model and the ceramic partial crowns were digitized by a structure light scanner with a measurement-uncertainty of 4 um and subjected to computer-aided quality inspection. Visual discrepancies in marginal and internal fit were displayed with colors. The results showed that Mean values for accuracy (reproducibility) ranged from 34 um for internal areas to 78 um for marginal surfaces. Differences in accuracy (p = 0. 003) and reproducibility (p < 0. 001) were statistically significant. In general, areas with sharp internal line angles such as occlusal ridges and the preparation finish line exhibited oversized dimensions, whereas areas with rounded and soft internal line angles were undersized.

Colpani et al in 2012 (23) experimented marginal and internal fit of ceramic crown copings. Ceramic (infrastructure) were fabricated using CAD/CAM technology and slip-casting technique, and metal IS were produced by casting (n = 10). For each experimental group, the adaptation was evaluated with the replica (RT) and the weight technique (WT), using an impression material (low viscosity silicon) to simulate the luting agent. Cross-sectional images of the silicon replica were obtained and analyzed with Image J software to measure the low viscosity silicon layer thickness at pre-determined points. The silicon layer was also weighted. The results showed that All IS evaluated showed clinically acceptable internal and marginal adaptation. Metal IS showed the best adaptation, irrespective of the measuring technique (RT and WT). The IS produced by CAD–CAM showed greater gap values at the occlusal area than at other evaluated regions. The IS produced by the dental laboratory technician showed similar gap values at all evaluated regions.

Mously et al in 2012 (24) investigated Marginal and internal adaptation of ceramic crowns fabricated with CAD/CAM technology and heat-press technique. The E4D system was used to fabricate 30 crowns for the first 3 groups, with different spacer thickness: 30 mm, 60 mm, and 100 mm. for fourth group, 10 lithium disilicate crowns were fabricated with the presstechnique. The occlusal gap, axial gap, vertical marginal gap, and absolute marginal discrepancy were evaluated by x-ray microtomography.

The results showed that Within the CAD/CAM groups, the 30-mm spacer thickness resulted in the lowest median axial gap (90. 04 mm), whereas the 60-mm spacer thickness resulted in the lowest median occlusal gap (152. 39 mm). The median marginalgap values of the CAD/CAM-60 group (49. 35 mm) and CAD/CAM-100 group (46. 65 mm) were lower than those of the CAD/CAM-30 group (55. 18 mm). No significant differences among the CAD/CAM groups were observed for absolutemarginal discrepancy. The heat-press group had significantly different values than those of the CAD/CAM groups.