Mechanical performance of posterior Implant supported Crowns using abutments with different angulations

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Dedication

- *To the soul of my beloved Dad and Mum….*

  For giving me strengths and support to be what I am now

- *To my Family; Sisters, Husband and my beloved Sons…*

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Fixed prosthesis is the most convenient type of restoration indicated for the treatment of partial edentulism. This is true whenever properly distributed healthy teeth that are capable of sustaining the additional load exist to serve as abutments.

Fixed prosthodontics becomes more difficult when several teeth must be replaced or when the abutment teeth are sound and such irreversible preparation may be un-acceptable then. [1]Treatment options for partially edentulous patients have been significantly enhanced with the advent of dental implants.

Implants have added options to successful prosthodontic rehabilitation formerly unavailable. A revolutionary practice of prosthetic dentistry is created through a new predictable alternative to the removable complete or partial denture.

The availability of endosseous dental implant systems with predictably high success rates has considerably extended the range of treatment options open to the restorative dentist.[2]

The anatomic configuration of the osseous structures may dictate placement of implants, and the position and angulations of the teeth adjacent to the edentulous space must also be considered.

A critical determinant for placement of an implant is the height and width of bone available in the edentate sites. The clinician also needs to evaluate the angulations of the ridge before placing the implant. Ideally, implants should be placed parallel to each other and to adjacent teeth and be aligned vertically with axial forces. However, achieving this may not be possible owing to deficiencies in the ridge's anatomy so implants have to be placed in angulated positions, thus angled abutments have been designed to correct the improper angulations of implants. [3,4]

An abutment angulations' is one of the biomechanical variables involved in implant dentistry that need scientific studies. Many studies evaluated and investigated the relation of the abutment angulations to the load transfer to the surrounding bone. [5]

The load transfer from implant to surrounding bone depends on type of loading, bone-implant interface, length and diameter of implants, shape and characteristics of implant surface, prosthesis type and quantity and quality of surrounding bone.[6]

Using angulated abutments with different types of restorative materials to construct the overlying crowns are important factors in determining the amount and distribution of the stresses loaded on the superstructure and implant under functional forces. [7]

However, over the last two decades, interest in more esthetically pleasing and metal-free superstructure restorations has increased the demand for all ceramic restoration and several systems are currently available that employ sophisticated computer-aided design/ manufacturing (CAD/CAM) technology for all ceramic restoration fabrication.

Ceramic materials can successfully replicate the esthetic qualities of natural teeth [8] and have low thermal conductivity.[9] However, despite their strength under compression, they are brittle materials, with limited tensile strength, and do not exhibit plastic deformation before failure.[10] Ceramic materials are also subjected to time dependent stress failure.[11] Microscopic flaws generate micro cracks that can propagate in response to relatively low stress values.

Demand continued for restorations exhibiting high strength, natural color, marginal integrity and ease of fabrication and wear resistance.

More recently, a new type of ceramic material, zirconia, based on zirconium dioxide, has been developed. Yttria-stabilized tetragonal zirconia polycrystal, Y-TZP, has a unique ability to resist crack propagation by being able to transform from one crystalline phase to another, and the resultant volume increase stops the crack and prevents it from propagating. This material has the potential to be used for larger restorations and in the molar area. (12, 13)

Today, CAD/CAM is the only means of producing durable tooth-colored and metal-free components in dental practice, including implant dentistry, and also provides the option of chair-side fabrication of indirect restorations. (14)

History and success rate of Dental Implant:

Implant dentistry is the second oldest discipline in dentistry after oral surgery. Root form implant history dates back thousands of years and included ancient civilizations.

The Chinese carved bamboo sticks in the shape of pegs and drove them into the bone for fixed tooth replacement 4000 years ago.

The Egyptians used precious metals with a similar peg design 2000 years ago. A skull was found in Europe with a ferrous metal tooth inserted into a skull with a tooth peg design that dated back to the time of Christ.

Incas from Central America around 600 AD took pieces of sea shells and, similar to the ancient Chinese, tapped them into the bone to replace missing teeth[(15,16)]

Many materials were tested, and in the early 1900s, Lambotte fabricated implants of aluminum, silver, brass, red copper, magnesium, gold, and soft steel plated with gold and nickel.

The first root form design that differed significantly from the shape of a tooth root was the Greenfield latticed-cage design in 1909, made of iridoplatinum [(15).] This was also the first two-piece implant, which separated the abutment from the endosteal implant body at the initial placement. The implant crown was connected to the implant body with an anti-rotational internal attachment after several weeks.

Seventy-five years later in Europe, this implant design was reintroduced by Straumann and later by Core-Vent in the United States. In 1946, Strock designed the first titanium, two-piece screw implant that was initially inserted without the permucosal post; The abutment post and individual crown were added after complete healing. The first submerged implant placed by Strock was still functioning 40 years later [(16,17).]

Brånemark began extensive experimental studies in 1952 on the microscopic circulation of bone marrow healing. These studies led to a dental implant application in the early 1960s in which a10-year implant integration was established in dogs without significant adverse reactions to hard or soft tissues.

A revolution in dental implantology occurred when Brånemark, the Swedish orthopedic surgeon, philosophy began in 1965, the Swedish team felt ready to apply its findings to human patients. Although they had originally planned to work with knee and hip joint surgeries, they instead selected as their first human subject a 34-year-old man who had been born with a deformed chin and jaw. Brånemark inserted four titanium fixtures into the man's mandible, and several months later he used the fixtures as the foundation for a fixed set of false teeth. The fixtures survived, the patient's life was transformed, and Brånemark resolved to develop more techniques for dealing with dental rehabilitation.

In 1976, the Brånemark method became fully covered by the Swedish national health insurance system, and Brånemark began training the first Swedish dental experts in his techniques in October 1977[(18)], when he discovered that bone could grow in proximity of titanium (Ti) , he used titanium implant and inserted it in a patient's mandible, and several months later he used the fixtures as the foundation for a fixed set of prosthetic teeth, the dental implant served for more than 40 years, until the end of the patient's life.[(19)]

The term osseointegration (rather than bone fusing or ankylosis) was defined by Brånemark as a direct contact of living bone with the surface of an implant at the light microscopic level of magnification. Today the term osseointegration describes not only a microscopic condition but also the clinical condition of rigid fixation. The osseointegration concepts of Brånemark have been promoted more than those of any other previous person in dental history.

Adell et al published the Brånemark 15-year clinical case series report in 1981 on the use of implants in completely edentulous jaws.[(20)] Approximately 90% of the reported anterior mandibular implants that were in the mouths of patients after the first year of loading were still in function 5 to 12 years later. Lower survival rates were observed in the anterior maxilla.

In 1982, the US Food and drug Administration approved the use of dental implants, and in 1983 Mr. Matts Anderson developed the Procera (Nobel Biocare, Zurich, Switzerland) Computer aided design and computer aided manufacturing (CAD/CAM) method of high precision, repeatable manufacturing of dental crowns. [(20)] Implant dentistry in the 1990s experienced a transition from functional rehabilitation to esthetics, with esthetic results improving throughout the decade.

Implant prosthesis in mandible:

Since Brånemark et al [(21)] published the results of a 10-year study on osseointegration in 1977, dental implants have increasingly been used to replace missing teeth. It was proven that osseo-integrated implants can successfully be used to restore the completely or partially edentulous patients with long term success [(22)].it was observed that implants placed in the anterior mandible of humans had a high success rate. Adell et al [(22)] reported that approximately 90% of the implants placed in the anterior mandible were still in function 5 to 12 years later.

However, in the posterior quadrants of the maxilla or mandible, the survival rates for implants vary among studies. [(23)] Generally, the success rates of implants in those regions are inferior to implants in anterior jaw locations. [(24)] In the maxillary posterior region, the proximity of the maxillary sinus and insufficient quality and quantity of alveolar bone may create problems during implant therapy. [(25)]
Sufficient amount of bone for implant placement is an essential pre-requisite for the long term success in oral implant therapy. Lack of bone volume always results in exposure of implant surface, decreased implant bone interface and finally implant failure. So change in bone morphology often dictates placement of

implants with long axis in different and exaggerated angulations to satisfy space and esthetics needs, so is difficult to restore with conventional (0^0) abutments. This can be managed either by surgical correction or by positioning the implant in the area with the greatest available bone, with the intention of correcting the implant alignment at the time of implant restoration. This is made possible in carefully planned cases, with the use of angled implant abutments [(26)].

However, the placement of implants in the posterior regions of the mandible is limited by the alveolar nerve canal and the mental nerve loop. In the case of inter-foraminal rehabilitations, an upright distal implant may need to be placed anterior to the mental foramina and the loop to avoid damaging the nerve. The use of tilted implants to avoid the mandibular nerve has been proposed. [(27)]

Angled Abutment in Implant Dentistry:

In general, the implants are inserted with an ideal angulation for prosthetic rehabilitation. However, in some cases, the anatomy and morphology of residual ridge may dictate an undesirable implant angulation for prosthetic restoration [(28,29)]. The anatomy of the jaws and the morphology of the residual ridges determine the orientation and angulations in which the implant has to be placed.

The abutment angulation is a mechanical variable in implantology [(30)]that may influence the internal and external structure of bone tissue. So, the bone behavior is related to the stress and deformation applied on it. The maximum angulation between implants using regular abutments is 30 to 40 degrees according to the design of settlement surfaces. The angulated abutment is available with 15 and 25 degrees of angulation for cemented segmented prostheses and with 17, 25, 30, and 35 degrees for screwed segmented prostheses.[(31)]