A CLINICAL METHOD FOR THE DIAGNOSIS AND TREATMENT PLANNING OF RESTORATIVE DENTAL PATIENTS

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This article describes a method of clinical diagnosis and treatment planning for restorative dental patients that emphasizes well-defined pre- and posttreatment communication between practitioner and patient.

KEY WORDS

Diagnosis
Treatment planning

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INTRODUCTION

The objective of the article is to describe a clinical method by which the clinician and the patient can establish a relationship in which there is a codiagnosis of the patient's pretreatment condition and the development of a treatment plan that fulfills the patient's expectations. The process allows for an organized documentation of the patient's pretreatment condition that will lead to appropriate and reasonable treatment options. The treatment can then be provided in phases. These treatment phases can then be completed in a sequence that is consistent with what is clinically appropriate and also compatible with the patient's and clinician's schedule.

Proper patient-doctor rapport, a thorough comprehensive written evaluation, and a multiphase treatment plan enhance the likelihood of surgical and prosthetic success of complex dental restorative cases. This process can effectively take place over the time span of 1 to 3 pretreatment appointments. The initial pretreatment comprehensive examination process generally requires a clinician to provide clinical time at a rate below the hourly revenues he generates during treatment time. Allowing adequate time for this process is prudent and allows a clear understanding of the patient's desires and pretreatment condition. The patient better understands treatment options and risks vs benefits; thus, appropriate informed consent for treatment is achieved. Treatment acceptance is much greater and the treatment provided is more effective and efficient in its delivery.

THE INITIAL CONSULTATION

The initial consultation is usually the first and briefest office assessment process. It allows for the completion and review of medical and dental history questionnaires and the preliminary evaluation of the patient emotionally and psychologically.

The consultation appointment allows an opportunity to get to know the patient and establish an appropriate rapport. Restoration of complex dental cases can take several years, and it is

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important that a healthy relationship be maintained with the patient throughout the process. The consultation appointment can be utilized as a screening process of patients in which the clinician establishes whether he can fulfill the patient's expectations and establish a long-term successful relationship.

The Comprehensive Diagnostic Examination

Following the initial consultation appointment, the patient is rescheduled for a comprehensive diagnostic exam. This appointment is generally much longer than the relatively short initial consultation.

The comprehensive exam is one of the most critically important aspects of restorative patient care. During the diagnostic examination, the patient's vital signs are documented and pertinent aspects of the medical history are further investigated. Screening radiographs, including a panoramic and a full set of periapical X-rays, are taken. The patient's chief complaint, desires, and expectations are written down. An extraoral examination followed by an intraoral examination is then performed.

The physical examination

The physical examination in most modern restorative dental practices is largely limited by the clinician's education and experience. It is generally accepted that a complete physical examination is neither necessary nor practical unless the clinician picks up physical or emotional abnormalities during the pretreatment phase.[1] According to the American Association of Oral and Maxillofacial Surgeons' (AAMOS) parameters of care for elective surgery requiring anesthesia, the only physical assessment requirement is vital sign assessment and an appropriate medical consultation with reference to any pertinent aspects of the patient's medical history.[2]

Due to the relatively long length of dental implant restorative treatment, the clinician must be sensitive to changes in the patient's medical status during and after the course of treatment. Medical evaluations including appropriate laboratory analyses have shown that some patients who had no systemic disease at the initiation of dental implant or bone grafting treatment sometimes developed serious diabetic disorders during the course of treatment. While the treatment itself did not initiate this disease state, the disease state did compromise healing. In certain cases, the stress of the treatment itself may exacerbate a subclinical condition into a serious clinical condition. In one specific case, a healthy-appearing white male in his mid 60s had several routine endosseous implants surgically inserted. Within 24 hours, the patient reported that, while his mouth felt fine, he had a black dot in the middle of his field of vision. It was discovered that the patient had plaque build-up in both carotids. The spot within his field of vision was manifested by some plaque that had broken off the carotid during the surgery and that impinged on the retinal artery. Within 2 weeks, the patient underwent bilateral endarectomies. In this case, the dental treatment may have allowed a relatively serious condition to surface or manifest itself. At the initiation of the restorative treatment, this condition was unknown to the patient or the restorative clinician.

As our patient population increases in age and patients are kept alive by more sophisticated medical treatment, the dental clinician must be more sensitive to subtle changes in a patient's medical status.[3]

Patient's chief complaint and expectations

It is important to document not only patients' chief complaints but also their desires and expectations. This will dictate the prosthetic needs and in turn the bone configuration and the abutments that are required. The patient's desires are best determined by asking value questions such as ''What is important for you with reference to your dental care?'' ''What is important to you with reference to your smile?'' Once you have documented the answers to these questions, you can start presenting information with reference to what is truly important to the patient. Communicating from the prospective of what is important to the patient opens up the patient's thinking process and engages the patient as a participant in the diagnosis as well as the treatment planning process.

It is also critical that the clinician clearly understands what the patient's expectations are. The patient and clinician should have a clear understanding regarding treatment options and the range of prosthetic results that correlate with the treatment options. If the patient's expected results seem unrealistic to the clinician, it is best that the clinician discuss and document this properly and recommend that the patient obtain several opinions prior to initiating treatment.

The extraoral examination

The extraoral examination allows for the evaluation of facial symmetry, skeletal profile, facial contours, and the patient's speech, skin, nose, and lymph nodes. Deviations in facial relationships may be indicative of pathology or may suggest esthetic or functional concerns, which can be addressed through either orthognathic or plastic surgery. Orthognathic surgery in edentulous or partially edentulous patients utilizing a LeFort 1 osteotomy and interpositional grafts can improve the surgical positioning of dental implants.[4] The evaluation of the patient's speech may indicate neurological, functional, or anatomical problems, which may be addressed by an ear, nose, and throat specialist or a speech therapist. Evaluation of the patient's skin may reveal localized pathology or a condition indicative of a systemic disorder. A referral list of qualified dermatologists and plastic surgeons may be provided to the patient if indicated. Enlarged lymph nodes may be indica-

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tive of infection or the presence of cancer.

The intraoral examination

The intraoral examination is a visual as well as a palpation process. Intraoral soft tissue is examined to discover preexisting pathology as well as to ascertain if the patient's soft tissue will be able to withstand the additional stresses that may be placed on it through increased function and irritation brought about by the use or maintenance of the final prosthesis.

The size of the tongue and parafunctional tongue habits must be evaluated. Lateral and frontal tongue thrust can displace natural teeth as well as certain types of implants. Infringement within the normal tongue space by implants or prosthetic components may result in chronic sore areas or compromised phonetics. Muscle attachments on the buccal or lingual aspect of natural teeth or near potential implant sites should be evaluated. Pulling on the soft tissue during the initial healing stage may separate incisions and compromise healing. Chronic muscle pulls after the completion of the prosthetic phase may create gingival recession, resulting in unacceptable prosthetic results.

Periodontal evaluation

Proper evaluation of the patient's soft tissue status allows for the development of periodontal and esthetic soft tissue surgery treatment options. Periodontal evaluation includes periodontal charting, periodontal disease classification, and documentation of the location and quantity of keratinized attached gingiva. It is recommended that a minimum of 1 mm of keratinized tissue be available around natural teeth and at least 2 mm around the neck of dental implants.[5]An evaluation of the attached gingival present over residual ridge areas may be noted at this time.

Skeletal evaluation

Skeletal profile classification relating the maxilla and the maxillary arch to the mandible and the mandibular arch is done with visual inspection, mounted study models, or, more specifically, by utilizing cephalometric radiographs. The skeletal profile has both esthetics as well as functional ramifications. Orthognathic surgery may be required to fulfill the patient's esthetics expectations or to develop a foundation for abutments that can be prosthetically loaded with stable forces.

The arch

The arch form is a configuration of the arches as viewed from the occlusal view. The geometric configuration of each arch should be viewed individually as well as how they relate to each other. Mounted study models can assist in properly evaluating the arch form as well as the interarch relationship.

The arch geometry impacts the position of dental implants, thus impacting the way the implants relate to each other in an anterior-posterior direction. A V-shaped arch would more easily lend itself to placing implants with a greater anterior-posterior ratio than a U-shaped arch or an arch with a relatively straight anterior ridge. The anterior-posterior relationship impacts the distance that one can cantilever a prosthesis. In a tissue-supported overdenture utilizing 2 implants, the implants are closer together in a V-shaped edentulous ridge compared with a U-shaped or square-shaped ridge. This limits the size of the connector bar as well as the retention clip.

The interocclusal relationship impacts how opposing abutments relate to each other. Usually, the greater the resorption process, the more lingualized the maxillary arch relates to the mandibular arch. Restriction of the maxillary arch congenitally, following orthodontics, or after prosthetic reconstruction may restrict the opposing mandibular arch. This results in posterior displacement of the mandible as well as the mandibular condyles. Restriction of the mandible to translate forward to a physiologically healthy myocentric relation may result in neuromuscular imbalance of the head and neck, leading to pain.

The interocclusal arch distance is the distance between the arches in a vertical direction. This distance may become overclosed as a result of supraeruption of the dentition into an edentulous space, posterior displacement of the condyles, or wear of dentition as a result of bruxism. The interocclusal arch distance may be increased as a result of loss of alveolar bone. This condition results in not only prosthetic esthetics challenges but also in increased lever action on the abutment system. The current state of the art as well as patients' expectations have resulted in significantly greater technical demands on the implant dentist. In cases where there has been significant lost of alveolar bone, onlay grafts followed by soft tissue reconstruction may be required in order to fulfill the patient's esthetics expectations. These procedures may be somewhat unpredictable in nature and may require several surgical procedures to achieve the expected results. The relative predictability of such procedures is related to not only the clinician's experience and surgical expertise but also to the patient's healing capacity. The clinician should consider systemic factors, including endocrinologic status, and social factors, including smoking, in assessing the prognosis of onlay graft procedures. The clinician must also consider postoperative resorption of bone as well as the fabrication of a provisional prosthesis for use during the healing stage that does not compress the graft.

Smile analysis

All aspects of the patient's smile should be analyzed and the patient's esthetics expectations should be documented. Preoperative digital photographs can be utilized to evaluate proportions as well as to properly document the pretreatment smile. The smile line is the curve created by the incisal portion of the maxillary teeth when the patient

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smiles. The incisal edges of the maxillary teeth should follow the curve of the lower lip. Reversed smile lines may be a by-product of functional problems such as an anterior tongue thrust or traumatic anterior occlusion. The lip line refers to the position of the upper lip as it relates to the maxillary anterior teeth and the gingival tissue when the patient smiles. The maxillary anterior teeth should show when the patient smiles without showing significant gingival tissue. Gingival and alveolar bone contours, including variations in height, should be documented.

Depending on the patient's esthetics expectations, esthetic periodontal surgery involving bone manipulation, soft and hard tissue recontouring, or connective tissue grafts may be indicated. The anterior arrangement of teeth, including teeth sizes as well as their positions in the arch relative to each other, should be documented. Orthodontic treatment may be indicated prior to the initiation of restorative treatment to achieve the patient's desired results. Slow, controlled orthodontic extrusion of teeth or roots as described by Maurice Salama et al[6] may be utilized to increase both alveolar bone and soft tissue height. Healing heads on dental implants, which conform to the root diameter, placed during the initial surgical phase will create a natural interdental papilla and emergence profile to the prosthetic crown.[7]

The patient's natural tooth color as well as the patient's color expectation of the final prosthesis should be documented. Advances in tooth whitening techniques as well as heightened cosmetic dental expectations have impacted the shade-selection process for prosthetic dentistry. In the last several years, 90% of the restored dental patients in our practice have A1 or equivalently shaded crowns. Natural teeth that are not restored are whitened through home or in-office whitening techniques.

Occlusion

The patient's existing occlusion should be evaluated. In cases requiring full-mouth reconstruction, a mounted study cast will be required to analyze existing occlusal schemes. Duplication of these casts will aid in the diagnostic wax-ups as well as the fabrication of provisional diagnostic prostheses.

The cuspid relationship as well the posterior tooth contact in centric as well as eccentric relationship should be documented. The patient's overbite and overjet are measured in millimeters as well as percentage of overlap. The Curve of Spee and the Curve of Wilson are measured as viewed on the mandibular arch. The posterior occlusal support of the mandible is noted. When the patient losses posterior support of the mandible, there is a dominance of the temporalis muscle over the masseter muscle, resulting in posterior displacement of the condyles and loss of posterior vertical dimension of occlusion. Posterior occlusal support of the mandible is a critical component in maintaining a healthy stomatognathic system as well as a good long-term prognosis of the final prosthetics. Proper occlusion is patient dependent and should be based on bioengineering principles that support that individual patient's stomatognathic system and the abutment-prosthesis apparatus.

The temporomandibular joint

Mandibular movement and range of motion are the primary indicators of the arthropic health of the patient's stomatognathic system. Alterations in mandibular movement may be indicative of temporomandibular joint (TMJ) arthropathy and neuromuscular imbalances of the head and neck. Auditory examination and palpation of the joint may give the clinician insight as to any possible internal derangement of the TMJ. While it has been shown that many patients have internal derangements of the TMJ and manifest no discomfort, it is recommended that, if the patient is undergoing major restorative treatment and shows the possibility of TMJ pathology during the initial exam, a magnetic resonance image (MRI) be done to give insight into the specific nature of the arthropathy.

Breathing patterns

Breathing patterns during sleep such as snoring and sleep apnea may be indicative of pharyngeal airway obstruction resulting from large tonsilar tissue, steep throat forms, macroglosia, or posterior displacement of the mandible. Large pharyngeal tonsils may stimulate an anterior tongue thrust to allow the patient to breath better. This tongue thrust can in turn displace teeth as well as some implant abutments. A patient may have to be referred for a tonsillectomy procedure prior to initiating certain anterior prosthetic procedures if the clinician suspects that the anterior tongue thrust is a by-product of a pharyngeal airway obstruction.

Edentulous ridges

The edentulous ridge classification described by Misch and Judy allows an organized thought process for describing edentulous ridge areas and subsequent treatment planning. Division A bone is greater than 5 mm in width and over 10 mm in length. It is adequate in all dimensions and root form implants are usually the implant of choice. Division B bone is between 2.5 and 5 mm in width. It is challenging to place a root form implant of adequate width in division B bone without manipulating the bone through expansion, grafting, or osteoplasty procedures to change the classification to a division A ridge. A division C ridge can either be lacking in height (C-H) or have inadequate width (C-W) to place a root form implant. Division D ridge is severely atrophied and is the most challenging to restore prosthetically.[8]

Radiographic and imaging examinations

A full set of intraoral radiographs along with a panoramic radiograph is an excellent preliminary method for evaluating routine patients in areas where anatomical structures are clearly

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visible. When conventional radiographs and clinical palpation reveal that fixtures of adequate length and width may not be safely inserted, linear tomography, computerized tomography, or interactive computerized tomography is indicated to properly evaluate the patient's available bone. Linear tomography is indicated when the buccal lingual width must be evaluated and there is not a substantial enough increase in the benefit provided by a CT scan to warrant the additional risk of the radiation associated with a CT. Computerized tomography is the method of choice for evaluating complex cases with multiple implants. The CT scan allows for the evaluation of numerous areas from the same data in order to select the most desirable sites for implant insertion. Interactive computerized tomography allows for a pretreatment virtual surgical and prosthetic assessment of the patient. Computerized tomography data can be reformatted such that the clinician can accurately evaluate the tomography and density of the patient's bone as well as insert schematic implants into the computer image. The clinician can further select prosthetic fixtures on the computer to develop an accurate 3-dimensional treatment plan for the patient.

Informed consent

There are 6 critical components that are needed by most states' informed consent statutes. The first is the diagnosis of the patient's condition requiring the proposed surgical or prosthetic treatment. The second is the nature and purpose of the proposed treatment. The third is the material risks, which are recognized by any prudent dentist or physician. The forth is the likelihood of success. The fifth is the practical alternatives that have been proposed. The sixth is the prognosis of the patient's treatment.

MULTIPHASE TREATMENT PLANNING

The nature of restorative dental treatment involving dental implants is much more complex and takes much longer to complete than conventional dental care. A multiphase treatment plan assists the patient in understanding the treatment options available and thus increases case acceptance. Treatment can be rendered in phases compatible with the patient's time and financial ability. Several treatment options can be described at each phase of treatment, allowing the patient the ability to choose acceptable alternative treatment provisionally, which can later be modified to ideal treatment options.

Periodontal treatment phase

The periodontal treatment phase is directed toward obtaining optimal health for the patient's periodontium as well as tissue surrounding potential implant sites. In the cases of patients with type 2 or type 3 periodontitis, initial therapy in the form of root planing and scaling may be indicated. Osseous surgery may be indicated for deeper osseous defects as well as to achieve various esthetic results that patients may expect. Mucogingival surgery can be done during the initial periodontal phase to obtain adequate attached keritonized gingiva or following the implant surgical phase. Esthetic periodontal surgery can be performed to enhance tissue contours. When restoring atrophied maxillas, the implants are often placed such that the prosthetic head exits through loose mucosa. In this case, it is usually easier to perform soft tissue grafts following implant insertion than it is before implant placement.

Exodontia and bone maintenance phase

The prognosis of potential natural teeth abutments must be evaluated as they relate to the final prosthesis. Natural teeth that are either severely periodontally involved, badly decayed, or malpositioned may need to be extracted. Following extraction, osseous ridge preservation should be critically considered. Allograft material placed into extraction sites can preserve the width of available bone to provide a better base for implant placement as well as to improve esthetics. If there is any form of infection associated with the tooth that is to be extracted, it is recommended that one wait at least a week to place the graft into the extraction site. The choice of graft material is largely influenced by when, following the extraction, one expects to place an implant. The faster a material turns over or resorbs, the sooner an implant should be placed into the site. If one places autogenous bone or demineralized radiated bank bone into an extraction site, one can predictably place an implant into the site within 8 weeks. When placing implants into recent extraction sites in the maxilla, the use of osteotomes rather than burrs may have an advantage in that the bone is compressed rather than removed. If one expects to wait a longer period of time, one should select a slower resorbing material such as resorbable hydroxiapatite. If one does not expect to place implants into a site in the esthetic zone, one may elect to place a nonresorbable material into the extraction site to preserve the contours under pontics.

Provisional prosthetic phase

The provisional prosthetic phase can be accomplished with a removable prosthesis or with a processed acrylic bridge if adequate abutments exist. The provisional prosthetic phase can be utilized as a diagnostic tool to establish esthetic arrangement of teeth and an occlusal scheme that satisfies the patient prior to the final prosthetic phase. The provisional prosthetic phase also allows the patient to function and maintain esthetics during the healing phase as well as during the time required to fabricate the final prosthesis. The provisional crowns can be utilized to develop tissue contours that conform to natural-looking emergence of anterior crowns.

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Bone manipulation and dental implant phase

The bone manipulation phase allows us the ability to change one division of bone to a more desirable division of bone. Implant site development through bone and soft tissue manipulation is often a critical element in obtaining the prosthetic result that the patient desires. The challenge presently is not simply to get an implant integrated but to have an implant properly integrated so it can be esthetically restored and support the stresses placed on it under function.

Misch and Judy described an organized method by which one can make treatment options with regard to manipulating the available bone. In division A bone, no manipulation is required. Root form implants of adequate width can be placed in an ideal location. In division B, one can expand the bone, do lateral or interpositional grafts, place thinner dental root form implants, place plate form implants, or do an osteoplasty procedure modifying the division B ridge to a division A ridge. It must be understood that placing thinner implants decreases the implant-to-bone surface area, thus increasing the stress on the implant and bone under load. One may need to place more than one implant of thinner diameter to properly bear the load of one larger diameter implant. When modifying a division B ridge by performing an osteoplasty procedure, the resulting available bone will have decreased height, thus increasing the crown-to-implant ratio of the final prosthesis. This condition may result in longer, unnatural-looking crowns as well as an increased lever arm acting on the implant abutment. A division C-W ridge deficient in width requires a lateral onlay or a composite graft prior to placing an endosseous implant. A division C-H ridge deficient in height may be restored with an onlay graft followed by endosseous implants or with a subperiosteal implant. Distract ional osteogenesis allows for the increase in ridge length in which an endosseous implant can be predictably inserted. A division D ridge is the most challenging ridge to restore, requires the most clinical expertise, and may result in the most significant complications during and after the course of treatment. This ridge can be treated with autogenous grafts followed by endosseous implants.[9] In the case of the severely atrophied mandibular ridge, a tripoidially designed subperiosteal implant may be considered. The possibility of a fracture of the ridge should be considered. The embryonic origin of cranial bone makes it significantly denser compared with iliac bone and less likely to resorb. One may consider grafting cranial bone over a dehisced mandibular nerve along with a tripoidial subperiosteal implant; this would increase the mass and strength of the body of the mandible while decompressing the nerve and the graft. Lack of internal stimulation of the graft has not resulted in disuse atrophy as observed when placing an overdenture on a graft utilizing bone taken from the iliac.

Prosthetic phase

The final prosthetic treatment phase should largely be the culmination of patient care inspired by the patient's expectations. The patient's healing response during the initial phase of treatment and the number and location of abutments will be the final determinant in the patient's prosthetic options. A multiphase treatment approach can allow prosthetic options that can be upgraded as the patient elects to do so. A denture can have additional retention by placing several implants, resulting in an implant-supported vs tissue-borne overdenture. If designed accordingly, this prosthesis can be modified by adding additional implant abutments into an implant-supported, implant-borne overdenture or possibly into a fixed prosthesis. The ability to upgrade the prosthesis allows the patient to achieve optimum treatment as it becomes financially feasible.

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