

## Prosthodontic Rehabilitation: Back to Future

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### Abstract

The story of prosthodontics is quite unique and that status has been maintained for quite a long time. In dental history, Prosthodontics appeared second to oral surgery has a treatment modalities. 1918 saw the Professional emergence of this specialty when few dentists who were interested in the field of prosthetic dentistry assembled at Chicago and sought to learn the techniques and concepts which were popular then. Prosthodontics has pioneered the field of reconstruction compared to all other medical specialties. Over time, Rehabilitation techniques have changed considerably. Prosthodontics has a branch possesses a unique set of characteristics that have shaped much of dentistry. This article explores the relevance of prosthodontics through a careful journey from the profound past to the exciting futuristic frontiers

Keywords: Prosthodontics, Prosthetic Rehabilitation, History, Past and Future

### Introduction

The professional emergence of Prosthodontics dates back to 1918<sup>1</sup>. A few dentists who were interested in the field of prosthetic dentistry assembled at Chicago and sought to learn the techniques and concepts which were popularly used in different parts of the United States of America. The major goal of the assembly was to correlate and develop the anatomic, physiologic and technical facets of Prosthodontics. It evolved into a major dental specialty through careful adaptations and innovation. Prosthodontics has pioneered the field of reconstruction compared to all other medical specialties. The story of prosthodontics is quite unique and that status has been maintained for quite a long time. The relevance of prosthodontics can be understood through a careful journey from the profound past to the exciting futuristic frontiers.

### Past: A torch bearer to present (7500 BC – 1900 AD)

Rehabilitative efforts of human beings have a profound history and the evolution of dentistry can be traced to 7500 BC. Drill holes were discovered on at least eleven molars from people buried in the Neolithic town of Mehrgarh, Pakistan<sup>2</sup>. Rudiments of partial denture services were evident in Etruscans during 700 BC where in extracted teeth and carved ivory was fastened with gold wire to the remaining natural teeth.<sup>3</sup> The first evidence of implanted teeth is attributed to ancient China .4000 years ago, they carved bamboo sticks in the shape of pegs and drove them into the bone for fixed tooth replacement.<sup>4</sup> In 600 AD Mayans used seashell segments to rehabilitate anterior teeth.<sup>5</sup>

The foundation of modern dentistry was laid in the year 1728 along with the publication of “Le Chirurgien Dentiste” by Pierre Fauchard which contained comprehensive descriptions of the construction of artificial partial dentures and full dentures. The treatise favored the use of human teeth and positioning springs.<sup>5</sup> Gold shell crowns and post retained in the root canal were used by Claude Mouton in 1746. He also recommended white enameling of gold crowns for a more esthetic appearance<sup>6</sup>.

In 1774, dentures were made from porcelain by Nicolas Dubois De chateau.<sup>1, 5</sup> Sir George Washington used a denture made of hippopotamus teeth and ivory.<sup>6</sup> Pfaff, a dentist from Frederick used gold foil to cap the pulp chamber.<sup>1,5</sup> In 1790, John Greenwood developed the first known dental foot engine. He adapted his mother’s foot treadle spinning wheel to rotate the drill.<sup>6</sup> The major

inventions were made in 19<sup>th</sup> century. In 1825, White Dental Manufacturing Company, Philadelphia began commercial production of porcelain crowns.<sup>1,3,5</sup> The molding process for vulcanite dentures was patented in 1864.<sup>6</sup> In 1885, Logan patented porcelain fused to platinum post.<sup>5</sup> During the infancy of fixed prosthodontics, William Hunter, a physician from Britain, campaigned against many practices prevailing in dentistry. Referring to fixed dental treatment he said it was a “gold traps of sepsis” and “mausoleum of gold over a mass of sepsis”. This forced a change in the direction towards the conventional methods of rehabilitation; to be precise the removable partial and complete dentures.<sup>7</sup> The fixed prosthodontics treatment was mainly confined to single crown replacement with a post extended to the pulp chamber. Adhesion and luting was not popular in those days and to overcome this, Winders-designed screw joint retention between the abutment teeth and the pontic.<sup>8</sup> In 1886, Parr proposed the use of extra coronal socket attachment for pontic retention.

James B. Morrison in 1871 patented the first commercially manufactured foot-treadle dental engine. Dental burs which could cut enamel and dentin smoothly and quickly, revolutionized the practice of dentistry and laid foundation to the tooth supported fixed prosthodontics.<sup>6</sup>

The understanding of the temporomandibular joint and occlusion was limited to devising a replica of hinge movement. James Cameron invented and improved instruments for arranging artificial teeth and to fasten the models on support which allowed opening and closing movements.<sup>9</sup> In 1896, Walker’s physiological articulators” with adjustable condylar guide was introduced.<sup>9</sup>

The concept of team work began in 1854 when Sutton and Raynor opened the first known dental laboratory in the New York City. In 1887, Stowe and Eddy Dental Laboratory was started and that was the first successful industrial-type laboratory in Boston.<sup>6</sup>

The key developments in Prosthodontic rehabilitation that followed included:

1. Development of the understanding of oral function and dysfunction
2. Evolution of the techniques for replacing missing teeth and restoring those damaged by caries or trauma.
3. Introduction of new materials, such as porcelain, vulcanite.
4. Development of new technologies for tooth preparation, diagnosis and prosthesis fabrication.
5. Development of teamwork and lab communication developed the crucial relation between technician and clinician during fabrication.

## Present: Illuminating the future (1901 – present)

The increased demand for esthetics and development of scientific knowledge and innovative technologies gave an initial push to the current scenario of developments in prosthetic rehabilitation.

### Removable Prosthodontics

Knowledge of rehabilitation by removable partial denture was based on Bonwill’s principles on bracing the teeth and soldering a plate.<sup>7</sup> In 1918, Fortunati introduced surveyors with a graphite analyzing rod, which accurately traced survey lines of the greatest convexities of the teeth. In 1922, Cummer described four basic components of RPD design viz. saddle (base), connector, retainer, and occlusal rest. In 1925, Edward Kennedy classified partially edentulous arches which laid a firm foundation for designing of removable partial dentures. Krol modified Kratochvil’s design leading to the emergence of RPI and RPA philosophy.<sup>10</sup> Removable Prosthetic rehabilitation which were developed in the latter half of 20<sup>th</sup> century witnessed the replacement of metal retainers with flexible resin materials which were nylon based and fiber reinforced acrylic resins.<sup>11,12</sup> Currently, Osseo-integrated implant supported removable prosthesis (ISRP) is a scientific and feasible treatment.<sup>13-16</sup> CAD CAM frameworks, printable wax or resin pattern framework for casting and direct laser sintering are presently the new trends of fabrication of RPD framework.<sup>17-19</sup>

The removable complete denture prosthodontics took a giant leap in 1900s. Several basic principles of making impressions were introduced. Advances impression techniques, method of border molding and obtaining peripheral seal took place during this period. The philosophies of impression making were developed.<sup>20</sup> Selective pressure technique developed the anatomical and physiologically ideal method of impression making. In the latter half of 20<sup>th</sup> century the material used for impression making has changed from crudely heated thermoplastic materials to soft putty materials.<sup>21</sup> Currently in the evolving era of digitization, the methods of impression are changing but the school of selective pressure remains unchanged. The emergence of digital CAE/CAD/CAM technology, computer designed and digitally manufactured denture is possible, in two appointments. The dawn of characterized printed dentures may see light at the earliest.

The fundamentals of gnathology, the concepts of centric relation, anterior guidance, occlusal vertical dimension, the intercuspal design, and the relationship of the determinants of mandibular

movements to the occlusion were recorded using complex instrumentation in complete denture prosthodontics. The foundation stone of gnathology was laid in 1908 by Norman G. Bennett through the article "A contribution to study the movements of mandible" reported that mandible had no single fixed centre of rotation for opening and closing movements. The endeavor of making a simulator of human gnathology saw its breakthrough in 1922, Hanau H model was introduced. Hanau also contributed to the understanding of balanced occlusion and Hanau Quint.<sup>22</sup>

In last 70 years occlusal concepts have changed considerably. Complete denture occlusion should satisfy the dynamic inter relationships between forces which stabilize and destabilize the denture, including freedom in centric, and the individual arrangement of denture teeth. A good occlusal philosophy combined with esthetics is of paramount importance in the patient acceptance of complete denture prosthesis. Currently Digital Volumetric Tomography (DVT) is providing more evidence on the condyle/fossa relation recorded during jaw relation.<sup>23</sup>

The pet acronym for a prosthodontists is RRR. The changes in the residual ridge of complete denture were questioned in 1971 by Atwood's article "Reduction in residual ridge". He changed the paradigm of thinking, the process which was considered a normal physiological phenomenon was now considered a pathologic process. Woelfel et al listed nearly 63 possible factors for RRR.<sup>22</sup> This provided the scientific basis for rehabilitative methods such as over dentures and immediate dentures. Frost's model on remodeling pattern of compact bone has improved our understanding on RRR.<sup>4</sup> In present scenario the over dentures supported by dental implants are capable of providing an altered functional stimulation to bone.

Rapid changes were seen in the materials used for fabrication of dentures; around 20 new synthetic materials were introduced. The first practical replacement to vulcanite was in 1939 by introduction of Veronite. By 1946, 95 % of dentures were fabricated by acrylic acid products since then methylmethacrylate polymer has been the undisputed material in Prosthodontics.<sup>22</sup> Only the method of moulding has changed from compression to injection and now milling. The days are not too far in obtaining characterized printed dentures.

### Fixed Prosthodontics

The fixed dental prosthesis rehabilitation evolved exponentially in 20<sup>th</sup> century. This branch has evolved from replacement of coronal structure of the teeth to rehabilitation with morphologically teeth like dental materials. In 1903, Charles Land devised the porcelain jacket crown. The

introduction of local anesthesia by Alfred Einhorn in 1905 made the dental chair experience friendlier. William. H. Taggart in 1907 struck gold literally by demonstrating lost wax technique of cast allowing dentists to make precision cast inlays.<sup>6</sup> The introduction of pre-wrapped intraoral films in 1913 increased the use and acceptability of X-ray in dentistry.<sup>24</sup>

In 1926, a Canadian dentist Irwin H. Ante postulated a guide on selection of abutment teeth for support in fixed restorations. It became a basic principle for fixed dental prosthodontics for many years.<sup>25</sup> Michael Buonocore in 1955 described the acid etch technique, this provided a breakthrough in adhesive techniques in dentistry. A simple method of increasing the adhesion of acrylic fillings to enamel. In 1957, John Borden introduced a high-speed air-driven contra-angle hand piece. The Airtor obtained speeds up to 300,000 rotations per minute, launching a new era of high-speed dentistry.<sup>6</sup>

In 1962, two major breakthroughs were made by Weinstein et al. They described the formulations of feldspathic porcelain that allowed systematic control of the sintering temperature and thermal expansion coefficient. An insight into the components that could be used to produce alloys that bonded chemically to and be thermally compatible with feldspathic porcelains was no more an unknown science. These development lead to popularization of fabrication of porcelain fuse metal crowns providing more aesthetically pleasing treatment modalities back then. The Adhesive technology was improved in 1962 by Rafael Bowen develops Bis-GMA, the thermoset resin complex used in most modern composite resin restorative materials.<sup>6</sup>

Rochette in 1973 introduced the concept of bonding a metal retainer to enamel using adhesive resin. His application was to splint periodontally involved mandibular anterior teeth using a cast gold bar bonded to the lingual surfaces of the teeth. It was considered aesthetic and minimal tooth reduction was necessary. The rehabilitations were now more based on scientific and evidence knowledge. It also included the development of fundamentals of tooth preparation with a holistic approach.

The concept of ferrule was also introduced. It was considered one of the prognostic determinants in restoration of endodontically treated teeth. Cast post remained the material choice in such rehabilitation. Currently fiber reinforced glass post is the preferred choice of material for restoration of post space because the flexural strength is almost similar to dentine, preventing the detrimental effect of possible root fractures.<sup>26</sup> The endocrowns are also proving to be a viable option of restoration.<sup>27</sup> The introduction of CAD CAM in 1983 changed the phase of fixed prosthesis. Since its introduction

it has changed production of ceramic restorations. The Machinable ceramics have stood the test of times clinically, it is considered superior in terms of aesthetics and internal fit in comparison with present available technologies of fabrication.

The prism of rehabilitation of edentulism (complete or partial) changed by the discovery of osseointegration and techniques of achieving it by Per-Ingvar Branemark. It is considered a milestone in rehabilitative techniques. The endosteal implants dominate the current practice of implants.<sup>6</sup> Implants are considered as a first treatment option to replace missing teeth. Dental implants eliminate the process of altering morphology of healthy abutment tooth for providing retention. The method of prosthetic retention of final prosthesis (screw retained or cement retained) still remains an enigma. The angulated abutments and zirconia abutments are used for providing more esthetically pleasing rehabilitation of teeth in the anterior zone. Currently prosthetic rehabilitation has evolved into a multi-disciplinary treatment than narrow specialty of replacement of teeth.

The key developments in Prosthodontic rehabilitation that followed included:

1. Development and understanding of biomechanics of the Prosthesis in relation to the field of gnathology.
2. Evolution of branches for further understanding of the specialty
3. Introduction of advanced diagnostic aids and concept of reverse engineering in the rehabilitative approach.
4. Integration of technology for the fabrication more aesthetic and accurate prosthesis.
5. Development of patient and practitioner friendly techniques and procedures.
6. A scientific multi-disciplinary and evidence based practices are becoming prevalent.

### Future: A cloud with Silver lining

The future of prosthodontic rehabilitation will be driven by digitization, globalization and urbanization. Specialty of Prosthodontics has always been at the forefront of technological innovation.<sup>28</sup> The conventional technique of 5 appointment technique can be reduced to single visit; concept of "teeth in a day" can be a reality.<sup>29</sup> The process from recording impressions digitally, to planning of implant placement and superstructure fabrication may take place in a digitized environment dominated by reverse engineering concepts.

Computerized fabrication of prosthesis in clinics is becoming a feasible option by use of milling and printing technologies. "Lab in Box" seems to be a reality in near future.<sup>30</sup> The concept of copy milling is making a leap to the future by milling anatomically customized dental implants. The concept of "Minimal invasive dentistry" will

receive boost by application of Nano robotics in preprosthetic and implant surgeries. The assessment of a successful prosthetic rehabilitation will be measured in terms of elevation in oral health-related quality of life (OHQoL) rather than mere numerical successes.<sup>31</sup>

Our understanding of edentulism has changed and will be evolved further. A minimum of 20 teeth, with nine to 10 pairs of contacting units, are associated with impaired masticatory efficiency, performance, and masticatory ability.<sup>31</sup> In the story of prosthodontic rehabilitations; it has come a long way from Hunter's concept of septic dentistry to association between tooth loss and mortality. From the wedging of tooth form seashells and ivory into the bone, to the current technique of replacement with root type dental implants, using CAD CAM technology for milling of Zirconia. Prosthodontics has been at forefront of technological innovation. It is conquering the new summits with proper amalgamation of art and science of dentistry with a futuristic vision. The patient expectation and satisfaction has been guiding light for evolution of the branch and will continue to be in the future.

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