





Prosthetic Rehabilitation

Part II: Technical Procedures

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Dedication

To the professors of the University of Turin—Dino Rocca, Giuseppe Ceria, and Remo Modica—who, more than anyone else, contributed to the development of the School of Dentistry in the late 1950s with their hard work, their passion for dentistry, their professionalism, and their dynamic teaching. The Section of Oral and Maxillofacial Rehabilitation was established in the mid 1970s in the culturally favorable environment created by these professors.



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Foreword

The past two decades of the 20th century were extraordinary ones for my discipline of predilection—prosthodontics. They ushered in a strong biologic focus, which gradually matched and perhaps even eclipsed traditional exclusive concerns with dental materials and techniques. The change was an inevitable and welcome one, and it belatedly paralleled the shift toward emphasis in basic and clinical sciences that had influenced development in the discipline. Neurophysiology, bioengineering, and health economics emerged as profound concerns in the effort to provide predictable treatment outcomes that recognized both patient as well as dentist-mediated concerns.

It is perhaps impossible to identify a specific text or event that catalyzed the much-needed changes. Most seminal events in history or breakthroughs in science tend to have similar origins—often unrelated, but ultimately convergent occurrences. Small streams of thought and experiment gradually converge to create a river full of force and momentum, which will in turn irrigate new sources of creativity.

My own academic development was influenced by particular Scandinavian works. The first was the 1977 article by Brill et al, “Ecologic changes in the oral cavity caused by removable partial dentures.”¹ The second was the 1977 monograph by Brånemark et al on osseointegrated implants.² Both sets of authors indirectly framed the prosthodontist’s twin concerns that must dominate evidence-based clinical decisions. These concerns can be posed as two questions: (1) What is the biologic price paid as a result of the diverse sequelae and consequences of loss of teeth? and (2) What is the biologic price inherent in the prosthodontic intervention? The very perceptive, if understandably limited, ecologic focus of Brill et al¹ gradually expanded from the notion of adverse ecologic shifts to far beyond those of plaque-induced and mechanical trauma. Brånemark et al,² on the other hand, proposed an entirely new model in pursuit of understanding the therapeutic benefits resulting in a scientific transition from an uncontrolled to a controlled induced interface. The impact of both ideas cannot be underestimated, particularly in the context of the subtle, yet profound, differences in dental, as opposed to medical, biotechnology.

Prosthodontics has been in the “spare parts” business for a long time, although we have done it with only a small degree of the anguish found in the medical field. As a result, we have not been unduly burdened with the sort of tricky ethical questions associated with genetics and organ transplantation.

However, our commitment to enriching our patients’ lives, rather than prolonging them, demands the same degree of scientific rigor in the way we make clinical decisions and carry out prosthodontic therapy.

The need for outstanding texts that articulate this new vision for prosthodontic rehabilitation has therefore become a serious and major priority. Professor Giulio Preti and his colleagues have provided us with such a text, and all of us in the discipline have been enriched by this masterful effort. I have been studying the Turin team’s contribution to dental scholarship—research, education, service—for several years, and theirs has been an exemplary record of commitment and leadership. They have distilled an enormous body of knowledge and wisdom in writing this book and presented their convictions in a lucid and highly organized manner. I have little doubt that this contribution stands out among those distinguished texts in the all-too-small canon of significant works in prosthodontics. Above all, the publication of this book is a compelling testimony to the purpose and meaning of clinical academics’ lives. Giulio Preti and his Turin colleagues deserve our gratitude for their outstanding contribution.

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Preface

There can be no doubt that scientific advancement is today articulated by papers published in specialized journals. Such articles measure the progress made by research, even when the truths they state are subsequently denied or enriched by the onward march of research. The sum of articles published by a research group or a school is a chronicle of what they have contributed to a field of research. But a book . . . a book is not part of a chronicle. Rather, it expresses the history of the steps through which a school was born, matured, and changed—in short, its evolution.

Over the years, two philosophies have had a strong positive influence on our thinking: the Zurich School, with Professor Albert Gerber and Professor Sandro Palla, which remains a constant reference point for continuing and new students alike; and the UCLA School of Dentistry, first with Professor Jim Krachtovil and now Professor John Beumer, in a collaboration of more than 20 years that has contributed to the education of several of our collaborators in the difficult art of maxillofacial prosthetics. In addition, Professor Remo Modica has become our maestro in life as well as in our profession. These individuals, with their enthusiasm and their commitment to the psychosocial aspects of prosthetic rehabilitation, have strongly influenced the direction our school has taken.

During the past 25 years of teaching, treatment, and research, our biennial congress has provided us with an opportunity to compare our progress against the world's most prestigious schools. Since then thousands of patients have been treated and hundreds of students trained in our department. Some of our alumni are now professors in various Italian universities including Bari, Bologna, Brescia, Ferrara, and Genoa. Each of these institutions is committed to giving continuity to the tradition of our school. Today, both our alumni and I believe we have achieved sufficient maturity to communicate our philosophy through this book. This publication represents 25 years of collective knowledge and experience. Each book tells a story, and we would like to think that this is our story.

Although this book is the product of many authors' work, it has a uniformity of thought, thanks to our common approach



Boves, Italy, July 2001, from the left: Professors Bassi, Carossa, Bucca, Preti, Pera.



Boves, Italy, July 2001, a working group.

and the professional contacts we have maintained over the years. In compiling this book, two fundamental concepts have been dominant: our teaching methodologies and the importance of providing supporting documentation from the literature. Today, when critically analyzing the effectiveness of new therapies, the predictability of posttherapeutic success has become crucial. Following in the wake of evidence-based medicine, evidence-based dentistry has now arisen, and within this, evidence-based prosthodontics. This approach can only help our discipline make better progress, where in the past, randomized controlled trials were rare.

Scientific progress in prosthetic dentistry has, nevertheless, not yet led to the large-scale adoption of new, improved therapies. For example, implant dentistry offers enormous therapeutic possibilities, but only a tiny fraction of the population has been able to benefit from this treatment. When treatment costs are high and patients' economic situations must be taken into consideration, traditional therapies maintain their value in comparison to new methods of prosthetic rehabilitation.

This text was split into two distinct parts. The first volume in this series discussed diagnosis and the components of prepro-



Cinzano, Italy, October 1978, on a seminar with Prof Gerber.



Pecetto, Italy, October 2001, a seminar for writing the book.

sthetic care, whereas this book discusses the clinical and technical aspects of fabricating functional prostheses for patients with different stages of edentulism. Taken together, these two books offer a more biologic and patient-centered approach to prosthetic treatment.

Some of these chapters have been written by our alumni who, while having worked as independent practitioners over the years, have maintained their professional ties with our department of prosthodontics, within which they have played or still play an active consultant role. These chapters, far from being exhaustive for those who are experts in the subject, discuss prosthetic aspects with two goals in mind: (1) to emphasize our department's philosophy of "comprehensive care"; and (2) to make the reader aware of his or her limits so that, on a case-by-case basis, he or she will refer to or consult with a specialist as required.

The multidisciplinary approach to prosthetic rehabilitation of the oral cavity is a complex process that proceeds through diagnosis and application of the necessary technical knowledge to design and construct a prosthesis to ensure long-term success.

Prosthetic treatment that modifies the oral cavity inevitably must consider the patient's physical as well as emotional needs. It is thus important to ensure correct communication so that we may understand our patients from psychologic, social, and cultural points of view.

Clinical evaluation continues with morphostructural and functional evaluation of the stomatognathic system. Whereas the former has long been considered indispensable and is routinely carried out, the same cannot be said for functional evaluation. Failure to appreciate disorders of the stomatognathic system before beginning treatment is frequently the cause of treatment failure.

The ecosystem of the oral cavity is modified by the presence of the prostheses, which may have a highly destructive

effect if the mechanisms involved are not properly understood. Knowledge of these mechanisms is based on the awareness that long-term success of the rehabilitation is the product of patient compliance and consistent follow-up by the dentist.

In this book, the various modalities of prosthetic rehabilitation of a stomatognathic system compromised by loss of some or all teeth are next taken into consideration. The first subject addressed is total edentulism because rehabilitation of the edentulous patient presupposes knowledge that is often indispensable in rehabilitating the partially edentulous patient. The discussion of rehabilitation of different degrees of edentulism is developed by considering different therapeutic options, ranging from the simplest to the most sophisticated. One of our goals was to provide the independent dental practitioner or the dental student with all those elements necessary to select the most suitable treatment for each patient, always bearing in mind that the patient is at the center of our interest.

No dentist can neglect a careful evaluation of his or her patient as a whole, from medical history to social and psychologic status, before formulating a personalized treatment plan. For this purpose we propose a guide to diagnosis and to the prosthodontic treatment plan in which, among other factors, every treatment considered ideal must then be adapted to the requirements of the individual patient.

In the final analysis, the treatment plan must address the articulated or perceived concerns of each patient. These important determinants of any successful treatment outcome include a symptom-free, esthetic, and functional result that does not incur risks of morbidity or unnecessary expense.

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An Explanation of the Criteria Used for Evaluating the Dental Literature

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Man prefers to believe what he prefers to be true.
Francis Bacon, *Novum Organum*, 1620

Experiments are the only means of knowledge
at our disposal; the rest is poetry, imagination.
Max Planck

A new scientific publication is the product of authors elaborating on the present knowledge of a specific subject through the mediation and integration of their personal experiences. A scientific text is, therefore, the product of detailed research from many sources that is presented in a natural and logical order. The success of this process is based on the ability of the authors to explain their arguments and the validity of what they have written. Even if the reader can easily judge the quality of the authors' ideas, this is not the case for the scientific accuracy of the ideas cited from other sources. How many readers take the trouble to check the bibliographic sources cited in a text? In order to provide readers with an additional means to substantiate their learning, every reference cited in this volume has been ranked by scientific weight, following the evaluation criteria and methodology published by Jacob and Carr.¹ In particular, every reference has been categorized according to the type of article (Table 1).

Scientific Validity

Technologic innovations of the last 20 years have forced dentists to acquire new knowledge and techniques to stay in step with the advances in the profession. Remaining up-to-date and assessing the efficacy and safety of new products, procedures, and techniques are becoming increasingly difficult, if not impossible, given the constant flow of information (not always

of high quality) presented in scientific journals, textbooks, and continuing education courses.

Making sense of these often contradictory sources requires a new skill—that of being able to select information that is valid and useful in clinical practice. The questions that dentists must pose to themselves are: (1) Is the information scientifically correct, and if this is the case, is it new and valid? and (2) Is it clinically important? We propose a hierarchical scale of assessment (see Table 1), based on the quality of the experimental evidence, to assist clinicians to select therapies for their patients that are supported by reliable verified data and to set aside those based only on personal opinion or equivocal data. Differences in scientific weight are determined by the type of source and the type of experimental study from which the data are obtained. The clinical relevance and practical utility depend instead on external evaluation of the research.

Sources

Scientific information that is the product of valid and repeatable experiments is published almost exclusively in professional journals that use a review system for selecting articles for publication. Such information is rarely obtained from books, courses, or continuing education conferences. Textbooks logically present the results of research that has already been published, and so is not new, as well as the opinions, usually implicit, of the authors. Often new results of experimental research are presented for the first time at conferences. However, given the limitations of the lecture format, it is not possible to present all of the information needed to evaluate or replicate the results of the studies and therefore determine their veracity. In addition, much research presented at conferences is not subsequently published.

All dental journals do not have the same scientific importance. The most prestigious journals ensure that all articles are evaluated by a group of experts (peer review) before being accepted for publication. Other less rigorous journals accept articles at the discretion of the editor alone.



One system of valuing scientific journals, called *impact factor* (IF), is based on the number of citations of the journal or its articles found in other journals. The IF index thus permits a valuation of the scientific weight of a publication. Articles published in a journal with a high IF have greater probability of being considered valid by the scientific community.

It is timely to recognize that nearly all dental journals that have a high IF are published in English. As in the 17th century the language of music was Italian, so in the 21st century the language of science is English.

Types of Scientific Articles

The Council of Science Editors has defined a *scientific article* as “the first publication containing sufficient information to allow colleagues to understand the observations, repeat the experiment, and evaluate the intellectual process.”² Clearly this definition is based on scientific methods enunciated by Bacon and Galileo in the 17th century. Essentially, to determine the validity of information, it is necessary above all to verify the methodology by which the study was made. For this reason, we have classified the various types of articles based on the hierarchy proposed by Jacob and Carr¹ (see Table 1).

Personal communications

Not everything printed in scientific journals is scientific. Personal opinions expressed as editorials, letters, or contributions to roundtable discussions are usually cited as *personal communications*. They are judged as hypotheses, ideas, opinions, and comments that are not to be confounded with data of scientific relevance, especially if the primary argument concerns questions that can be tested in experimentation. More rigorous critical evaluation must be applied to informative leaflets provided by manufacturers to publicize and promote the sale of their products.

Case reports

These articles introduce a new technique or results of a new product used in a limited number of cases. Their scientific importance is exclusively chronological, only establishing the author as the first person to propose the innovation. It is clearly impossible to draw extensively applicable conclusions based on the results of one or two cases that were followed for a very limited time period and, above all, derived from observations that have no analytical design.

Reviews of the literature

Traditional review articles are narratives, often the work of only one author, that comment on publications on a specific topic, in a uniform fashion, from the author’s point of view and experience. The scientific data reported in such articles are drawn from various types of studies, often not selected in a systematic manner, and not evaluated in a standard mode. Reviews with these characteristics, though useful as a synthesis of a particular argument, risk presenting conclusions that are not reproducible and that reflect, in some measure, the opinion of the author as well as those expressed in the reviewed literature.

In vitro experiments

In vitro experiments are carried out in laboratories using models to, more or less, reproduce clinical reality. They are the overwhelming majority of studies published in dentistry and prosthodontics because of the ease of execution and limited expense. Numerous types of models are used, including mechanical, computerized, and those using extracted teeth. The conclusions that can be drawn from such experiments are often difficult to accept as conclusive scientific proof, due to their evident limitation as only partially reproducing the clinical reality, which is decidedly more complex and practically impossible to represent using such defined models.

Animal studies

Animal studies provide a first approximation of what happens in the human oral cavity; the higher the animal subjects are in the evolutionary scale, the better the experiment will approximate results found in humans. Because animals can be sacrificed in experiments, important data can be obtained, particularly in the area of histology. Obvious differences between the oral cavity of animals and that of humans, however, limit the validity of this type of study.

Clinical studies

Studies with consenting humans are without doubt the principal sources from which we can draw reliable information for daily clinical practice. For the numerous types of clinical studies, the scientific weight increases as study variables that may influence the results are strictly controlled. Schematically, clinical studies can be divided into two primary categories: (1) *analytical studies*, in which there are two groups of subjects, one that receives the experimental treatment and the other that serves as a control; and (2) *descriptive studies*, in which there is no control group. These categories, in turn, can be

subdivided into two types: *experimental*, in which treatment is assigned to randomly defined groups of subjects according to a research protocol; and *epidemiologic* or *observational*, in which the treatment is assigned to subjects without the control of the researcher.

Experimental studies

Prospective controlled, randomized studies, in which the experimental treatment is assigned to two homogenous groups, represent the “gold standard” on the methodologic plane for evaluation of efficacy. In a randomized controlled trial the inclusion of a group of subjects that is identical to the group under treatment serves as a control to verify the real efficacy of the therapy or the experimental diagnosis. For example, in pharmacologic investigations, the control group is given either a pharmaceutical placebo or a drug that is considered the present standard treatment. In these studies, it is important that the distribution of the subjects between the two groups is completely randomized and double blind, in which neither the participating patients nor the researchers know which type of treatment is being followed. This allows a probable uniform distribution of the various prognostic factors and of possible unpredictable variables.

Studies in which subjects are assigned to a group in a manner that is not completely random are known as *quasirandomized controlled trials*. When the control group is made up of the same subjects who receive the various treatments (experimental and comparative) in two different periods, this is called a *randomized crossover trial*.

Observational studies

Nonexperimental epidemiologic studies can be of two types: (1) *case controlled studies*, in which a group of subjects with a certain problem are confronted with a homologous control group that does not have the problem to identify the relevant factors that might be responsible; and (2) *cohort studies*, in which subjects who have received different treatments are followed over time to evaluate the incidence of relevant clinical events.

Systematic review of the literature (meta-analysis)

Systematic literature reviews are conducted according to a rigorous and explicit protocol that prescribes criteria for the search, selection, and evaluation of the literature on a defined topic. Meta-analysis studies gather together and statistically analyze similar clinical studies, often with limited samples, providing reliable scientific data because of the overall higher num-

bers of subjects involved. Fundamental to this kind of analysis is the comparability of the various clinical studies taken together. The scientific relevance of these analyses is given by the affiliation of the studies that are compared.

Descriptive studies

Clinical studies are defined as *descriptive* if an analytical control of the experiment is not possible because of the lack of subjects that can act as a control group. If the therapy or the diagnostic procedure for analysis was already accomplished before the patients were selected for the study, it is called a *retrospective study*. If, instead, the individuals were selected prior to the experiment proceeding, it is a *prospective study*. Because of the possibility of controlling patient participation and the execution of the study, prospective studies are more relevant from the scientific point of view than retrospective studies.

Conclusion

The majority of studies presented in the prosthodontic literature fall into the categories described here. Undertaking experimental or observational studies is very difficult because of practical concerns (eg, the difficulties of always having a control group), economic funding (ie, scarce economic resources available for dental research), and the high degree of individualization in prosthodontic therapy.

Most articles in the prosthodontic literature are derived from *in vitro* studies, which are easier and more economical to carry out but of inferior scientific weight. The few clinical experiments of long duration concern, above all, retrospective epidemiologic analyses without control groups. Despite the infrequent publication of prospective clinical studies, such articles (eg, work on implant osseointegration) have been essential to advancements in dentistry in recent years.

Table 1 Evaluation categories for cited references

Category 1	Experimental clinical analytical studies
Category 2	Observational clinical analytical studies
Category 3	Prospective descriptive clinical studies
Category 4	Descriptive clinical studies
Category 5	Animal studies
Category 6	In vitro studies
Category 7	Books and narrative reviews of the literature
Category 8	Case reports
Category 9	Personal communications



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