Dental Biomechanics

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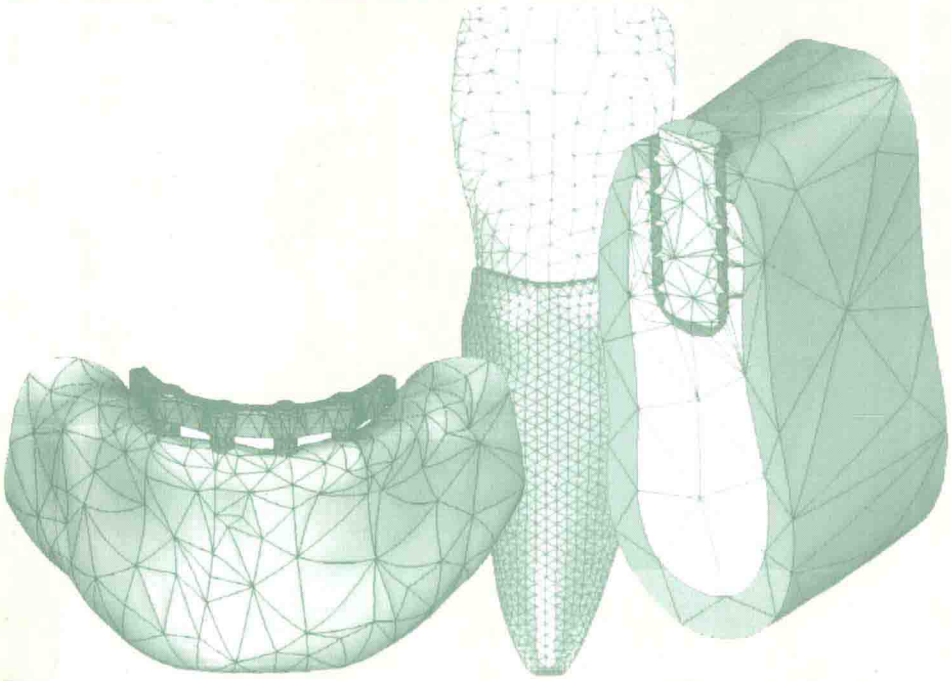
Arturo N Natali



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Preface

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Thus my plan here is not to teach the method that everyone must follow in order to guide his reason, but merely to explain how I have tried to guide my own.

Those who set themselves up to instruct others must think they are better than those whom they instruct, and if they misguide them in the slightest they can be held responsible.

But, since I am proposing this work merely as a history or, if you prefer, a fable – in which, among a number of examples that may be imitated, there may also be many others where it would be reasonable not to follow them – I hope it will be useful for some readers without being harmful to others, and that everyone will be grateful for my frankness.

. . .

. . . I hope that those who use only their pure natural reason will be better judges of my views than those who trust only ancient books. For those who combine common sense and study – and I hope that they alone will be my judges . . .

. . .

I would say only that I decided to use the time that remains to me in life for nothing else except trying to acquire a knowledge of nature, from which one could draw some more reliable rules for medicine than those we have had up to now.

René Descartes, "Discourse on method"

I consider it essential to question my dedication to research and, once I am in the midst of it, to reflect on the outstanding privilege of treating the mechanics of biological tissues. I like to consider the approach to be taken on, aiming at the integration of all of the knowledge and competencies that are a part of the research. The significant complexity of biomechanical processes is the manifestation of a superior formulation. Nevertheless, problems that may at first appear insurmountable, can be successfully interpreted by means of an attentive and humble approach that can lead towards the definition of a realistic final configuration. The functional response of biological tissues is, in and of itself, a fundamental reference, which can then be used to access the mechanics within the biological phenomena being dealt with.

The strong desire to reach a solution, or the reduced potentiality of the resources adopted for the investigation, should not lead to inadmissible approximations. On the contrary, regardless of how they have been chosen, they must be evaluated for the implication they have on the reliability of the final result, and should represent a cautious passage towards a more complete interpretation. A comparison of the results deriving from subsequent models, whose accuracy has been improved by taking the characterising aspects into account, will tell us how appropriately the investigation has been carried out. These models will be milestones, which confirm that the right course has been taken.

With this in mind, the mechanics written in biological phenomena should be read leaving aside the fear of facing their enormous complexity; however, at the same time the researcher must also be guided by the precaution taught by experience. The researcher should not be tempted by immediate results, even if they are attractive, rather than seeking deeper insight into the subject at hand. To carry out research in this way, an ethical approach must be taken, coupling biology and mechanics by using the most updated methodology. Mechanics, physics and chemistry are strictly related to clinical practice for the evaluation of the operational reliability of the results obtained.

I intend to report part of the experience and results deriving from many years of activity, in research and education, regarding dental biomechanics. When presenting this work, I am faced with problems pertaining to form and depth with regards to different aspects of bioengineering, which must be treated while remaining compatible with clinical knowledge. The difference in the methods in these cultural areas makes it difficult to propose a unitary presentation of the problems dealt with. Nevertheless, great effort must be made to overcome this discrepancy, with the aim of arriving at a fruitful confrontation and moving towards a unitary definition.

The cooperation efforts between bioengineers and clinicians have proved to be a challenge. It is necessary to be realistic and consider the significant difficulties inherent in this situation. As Renè Descart stated, "If artisans cannot implement immediately the invention I explained, I do no think that, for that reason, it can be said to be defective. Since skill and practice are required to construct and adjust the machines that I described, even though no detail is omitted, I would be just as surprised if they succeeded on their first attempt as if someone were able to learn to play the lute very well in a single day, when they are provided with only a good tablature".

I hope that the final results of this challenge, rather than displease both engineers and clinicians, promote the substantial integration of interest and engagement in facing sophisticated biomechanical problems.

The structure of this work is based on the intention of describing a sequence of events that, in a general sense, should characterise the biomechanical analysis in the dental area. First of all, the mechanics of hard and soft biological tissues, namely the bone and periodontal ligament, is given. Following this characterisation of materials, the geometric configuration of the anatomical site is defined, using tomographic techniques, along with a description of pre-surgical procedures. A significant portion is devoted to the definition of the materials used in dental practice, with regard to both implantology and orthodontics, considering specific manufacturing techniques as well. In the same way, the clinical aspects are reported because of their relevance to practice in implantology and orthodontics. The numerical approach to the biomechanical analysis of dental problems is presented in order to describe the potentialities offered by numerical simulation. A summary of the mechanics of materials, in terms of basic formulation, is reported, as a fundamental reference for approaching the biomechanical aspects treated.

The outstanding complexity of biomechanical phenomena expresses a level of optimisation that seems inaccessible for our knowledge, and is source of wonder and respect. The careful consideration of the magnificence of this reality should move anyone involved in this investigation to humility, and to great dedication. Even if this involvement pertains to the definition a small portion of a problem, it could nonetheless represent a great achievement. To be aware of our own position within the field of knowledge constitutes a preliminary requirement for knowledge itself.

A discussion on method and knowledge becomes a unique task, passing through the ethics of the person, with the aim of achieving a common end. If my work could serve the purpose of a better integration of researchers and teachers who differ because of their scientific education, I hope it could also serve the purpose of helping create better understanding among the people themselves.

I would like to thank everyone that helped me to give substance to these thoughts. For this, I give my profession of gratitude.

Arturo N Natali

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