

Preface

Today, although the orthopedic surgery has come a long way through adaptation/integration of modern tools such as sensors and computer aided drawing (CAD) based generation of patient specific defined joint design and bone machining parameters, it is still largely conducted by the surgeon using conventional tools such as saw, ultrasonic cutter, hammer, drill, etc. Such mostly conventional way of orthopedic surgery is associated with human and tool attributes and hence leaves tremendous room for further development of operating tools and techniques. The further developments are likely to address adverse effects of orthopedic surgery such as but not limited to: severe damage of tissues within and surrounding repaired/operated regions, low precision in final dimensional tolerance on repaired/operated bone, relatively slow surgical processes, post-surgery tissue trauma, rigorous pain, and in some cases post-surgery and related addition of cost.

In light of this, this is the first book that provides a comprehensive review of the machining of bones and hard tissues for orthopedic surgery through points of view of engineering and biology. The book begins with a description on the types of orthopedic surgeries and their societal and economic impact. Such description was intended to underscore the growing importance of the field of orthopedic operations and the need and scope for further research and development in the field. The complexity of orthopedic surgery can be realized from the complex nature of bone in terms of its chemical and physical components and their properties. These aspects are covered in the following sections on bone characteristics and physical and biological effects of orthopedic surgery. The success of an orthopedic surgery for precision and minimal damage to the bone and surrounding tissues depends on the understanding and control of basic mechanical operations of the surgery. The fundamental physical principles and the interactions of process parameters associated with the mechanical operations such drilling, sawing, grinding, and milling along with thermal machining and associated machinability and resultant surface quality are the topics of the next chapter. Although the procedures in current orthopedic surgeries are mostly founded on the above mentioned mechanical operations, several non-conventional techniques such as laser, microwave, ion beam, ultrasonic,

waterjet, pneumatic, and hydraulic machining are being researched as potential replacements for conventional mechanical operations in bone machining. Description of these unconventional machining techniques is the topic of the subsequent chapter.

The book further extends the discussion on physical aspects of the machining in view of material (bone) and process parameters followed by a discussion on temperature analysis. Often, temperature rise is unintentional consequence of the conventional mechanical operations as well as that of some of the non-conventional methods whereas it is one of the inherent processing parameters of non-conventional machining techniques such as laser/ion beam machining. Hence, development, measurement, and control of temperature during these processes are elucidated in the following chapter. In depth understanding and predictive effects of mechanical and thermal loading during machining operations on the basis of computational modeling is the topic of the next chapter. Such description on the computational approach is intended to assist in planning and optimization of the process/procedure and system development for orthopedic surgery in clinical environment. Finally, the potential of fully integrated automated machining operation in clinical environment is presented in the last chapter. The comprehensive discussion of this book expected to lay the foundation for efforts toward future development of improved orthopedic surgery with semi- or full automation, high precision, rapid procedure, minimal invasive tissue-damage, no blood transfusion, improved implant integration, and reduced cost.

As per authors' knowledge, currently this is the only book on the present topic available in the body of open source literature. Especially, the uniqueness of this book lies in multidisciplinary nature of the subject matter which in turn likely to remain a valuable source of literature to scientists, engineers and academicians working in the area of bioengineering, biomedical engineering, manufacturing science and engineering, application engineers and scientists/researchers working in the manufacturing, orthopedic, and medical industry, and senior and graduate level students in biomedical/bioengineering, mechanical, manufacturing, and materials science and engineering. The authors are grateful to all researchers working in the area whose literature in various sources remained the basis of content of this book. Finally, the authors also thank Anurag Roy for conducting extensive literature search related to the subject matter that provided the initial path for the content discussed in this book.

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