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Contribution to the Current Trends in Digital Foot Surgery Planning

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Abstract

There are various tools for application of digital technologies in the planning of orthopedic surgery. However, in practice there is always a need for new solutions, with tendence to achieve a balance between functionality and ease of use. We decided to complement the existing practice with our solution that will enable the surgeon, a set of the tools needed to implement the surgery over the foot bone structures. The program also enables 3D reconstruction , and work in the 3D interface with all necessary tools for manipulation, simulation, measurements and other actions in order to define optimal parameters for the implementation of the intervention. These parameters are ultimately stored in the final report, which gives the operator a clear guidelines on each of the procedure step. As a result of the implementation of such a plan it is also possible to obtain a virtual model which can be physically produced, thus providing the ability to practice procedures over the real model.

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Keywords: digitizing; digital measuring device; 3D reconstruction; virtual model; digital surgery planning; path generation

1. Introduction

Orthopedic practice has not been bypassed by revolution in the application of digital technologies. The need for faster, more accurate, simpler and cheaper methods, which aim to improve the practice and allow all participants in the clinical process less stressful and better implemented method, and a better outcome of the procedure, becomes imperative. With a given problem, engineers and programers have got a number of tasks with the aim of finding out better solutions for the given problems on daily basis.

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Advances in imaging technology and computer science have improved orthopedic practice in numerous ways[1]. The application of digital methods in orthopedics has enabled better planning of surgery both in terms of corrective and in the reconstruction of bone after trauma[2,3]. Before the advent of CT and MRI technology planning orthopedic surgery was predominantly based on the use of traditional radiographs. The analysis of the given material was carried out mainly on the 2D image taken from multiple views. Some authors created a methodology that has enabled us to, with use of such material, knowledge of the parameters under which they were recorded, and established correspondences between the images,a 3D wireframe model, which provides a simplified geometric basis for further analysis, was created[4]. However,due to complexity of the geometry of the bones,a higher quality and accuracy of the reconstruction is required, because based on this data it largely depends the outcome of the planning, and the surgical procedure. This issue has been significantly resolved with the progress CT diagnostic devices, which provide images in high resolution, yet with far less radiation dose. 3D reconstructions derived from such materials provide far better description of the surface of the bone and other structures essential for the implementation of the planning [5].

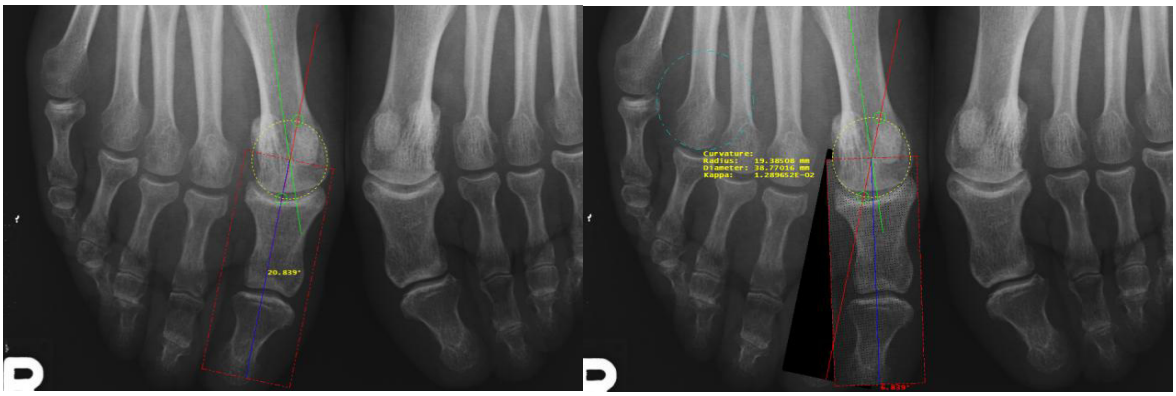

Fig. 1. Preoperative measurements conductedover x-ray images.

The logical continuation of the surgical planning is the implementation of its results in practice [6]. Here are primarily imposed on the use of navigation systems, the application of robotic technologies to physical implementation, or to assisting in surgical procedures in practice, and the development of physical models of deformed or traumatized bone of interest with the aim of practicing of surgery. Today, in practice we can find numerous applications that are intended to enable clinicians for planning of interventions based on available material obtained during the various diagnostic tests. For applications that are used in orthopedics, common approach includes implementation of surgery planning based on the results of radiological examinations. This includes 3D reconstruction from CT or MRI DICOM images, and / or the use of calibrated conventional radiographs through 2D or 3D software packages. Such programs allow measurement and manipulation aimed at defining the optimal approach to intervention in terms of defining the individual steps and related parameters. Problems with broader deployment of digital planning of surgical procedures in orthopedic practice include several aspects. They are manifested in the fact that it is still a young discipline, and there is a lack of quality retrospective analysis of the experience with these systems. Also these digital systems are often developed separately based on the experiences and needs of individual clinics, and due to this fact there is a discrepancy in the definition of the methodology accessing a particular practical problem.

In addition, although such programs are usually passed extensive preclinical testing, a large number of solutions lacks intuitive dimension, and it often happens that surgeons give up the application of these tools because work with them takes too much time, or such applications have too engineering character. Besides, these applications often do not cover most of the needs, so several tools need to be combined. One of the major problems that users encounter in the work is the inability to adapt these programs to the specifics of their practices. Manufacturers are in most cases very secretive and surgeon has no choice but to expect that in one of the future editions, solutions for at