Towards an advanced clinical expert system for patient-specific modeling and musculo-skeletal (MS) analysis?

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INTRODUCTION

Current data collection procedures include numerous tools to collect data related to any part of the musculoskeletal system (MS) and its functions. Unfortunately, the MS complexity makes the simultaneous use of the above procedures difficult. The amount of procedures to possess is so large that no research center possesses them all. Therefore, inhomogeneous datasets must be first obtained from various sources (e.g., literature, colleagues), and registered if one wished to build complex MS models. Data format conventions and validation is therefore an important issue to insure the quality of the final models. Clinical data collection is even more problematic because of ethical constraints (no use of invasive tools), and time constraints (some category of patients are rapidly tired).

Clinical MS analysis of patients is highly complex [1]. However, clinicians mostly rely on their experience and expertise to draw therapeutic conclusions because of the lack of other efficient tools. This lack is due to the current shortages (see above) of the state-of-the-art to generate a fully anatomically accurate and patient-customizable MS model.

Technologies found in modern simulations systems include advanced registration algorithms [2,3], state-of-the-art display [4], dynamic simulation [5], decision-making analysis [6,7] and knowledge-based management [8]. Most of them answer some local practical questions, either at fundamental research level or at clinical level. Unfortunately, most of these efforts appear to become not usable once it is exported to other locations where local needs or local resources are different.

This poor transportability of resources (data, hardware, protocols, software code, people, etc) can be explained at various levels: - complexity of the problems; - non-inhomogeneous data; - multidisciplinarity; - lack of standardization; - lack of consensus about the goals to reach; - etc.

In summary, numerous efforts are currently spent in the world to answer local clinical needs. Unfortunately, none of them has been large enough to deliver a truly patient-specific clinical analysis tools.

METHODS

A potential ideal system (Figure 1) would combine most above available technologies. It should be based on an anatomically accurate database including all components necessary to generate generic MS models using advanced registration tools (full arrow). Some parameters of the MS models will be registered to patient-specific data obtained through clinical analysis (dotted arrows). Knowledge-based algorithms that will offer a decision-making support to clinicians will then statistically analyze the "patient-customized" models.

RESULTS

The final report produced by the system would help clinicians to orientate their diagnosis and final conclusions based on objective data analysis.
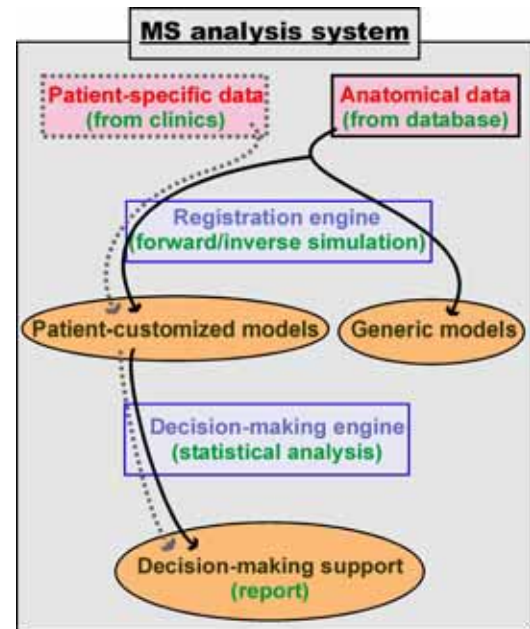

Figure 1. Sketch for MS analysis system.

DISCUSSION

Such system is technologically possible, but will need an important, and well-organized multidisciplinary effort to gather all necessary expertises. This paper would like to emulate a discussion to determine is such effort is practically achievable. This will require a long-term effort coming from all fields available in Biomechanics.

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