# AUTOMATIC REAL-TIME TOOL FOR THE PATIENT-SPECIFIC PERFORMANCE EVALUATION OF IMPLANT-SUPPORTED DENTAL REHABILITATION TREATMENT

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## Introduction

Finite element models are used to assess short and long-term behavior of bone, implants and overall treatments [1] offering interesting information as stress and strain distributions and values.
To ensure their clinical applicability, these methods must: 1) be semi or fully automatic, be real-time and return clinically relevant indicators. The objective of this study is to develop this tool and to assess its clinical relevance for a given clinical case.

## Methods

From CBCT imaging and planned treatment information (implant reference and position), the MEDSCOPE software works in four steps. Firstly, the specific material properties were automatically computing around each implant from the CBCT imaging of the patient and the implant position coordinates. Secondly, based on the expected global occlusal force (force level and orientation), the resultant force and moment were computed for each implant using a 3D bar finite element model. Given this information (specific material properties and specific loads), detailed finite element models of bone-implant unit (including implant, surrounding bone and bone-implant interface) was automatically generated for each implant of the evaluated treatment, based on a previously validated FEM [2]. Stress and strain results are then used to compute three biomechanical criteria for each implant (Bone safety index, Osseointegration index and implant safety index). Given these criteria, specific weighting factors and considering the number of implant use for each treatment, a global score was computed.

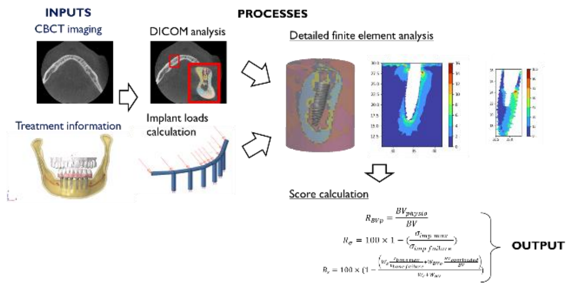


*Figure 1: Workflow of the MEDSCOPE 1.0 software from inputs data to*

This method was applied to the evaluation of a patient-specific implant-supported prothesis of eight artificial teeth supported by: 6 implants (6DI), five (5DI), four (4DI) and three implants (3DI). For each treatment, implants were positioned with the help of a surgeon.

## Results

The entire process successfully operated from input data (CBCT data, implant reference and coordinates) without any user action requirement. The nominal time for the evaluation of a complete treatment is less than five minutes.

| Criteria | | 3 DI | 4 DI | 5 DI | 6 DI |
|---|---|---|---|---|---|
| Mechanical results | Min BSI | 28% | 62% | 61% | 65% |
| | Mean BOI | 82% | 62% | 33% | 26% |
| | Min ISI | 75% | 72% | 87% | 77% |
| Global Score | | 65% | 75% | 72% | 69% |

The minimal ISI computed for all the implants of a given treatment is over 70% in all cases, indicated no significant risk of implant failure. The minimal BSI, indicated the higher risk of bone failure, is found for the 3DI treatment. Whereas, the difference is non clinically significant between four, five and six-implant treatments. The mean BOI decreased with the number of implants used indicated lower osseointegration potential for five and six-implant treatments compared to three and four-implant treatments. Finally, the maximal global score is computed for 4DI whereas the lower one is computed for the 3DI treatment.

## Discussion

The developed tool enabled to automatically model and simulate *in-use* behavior of four complete patient-specific treatments, previously defined by an experimented surgeon, without any user action and within very short delay compared to usually expected in dental implantology. The global score, based on biomechanical criteria, suggest better global performance of the four-implant treatment compared to the other ones. This is explained by a higher osseointegration potential than five and six-implant treatment with similar bone and implant safety rate. experiment. This study showed the feasibility of the MEDSCOPE software to automatically compare treatment plan and help surgeons in analyzing the results. The next steps will consist in an extensive biomechanical criteria validation based on a retrospective study design.

## References

1. Dogru et al, J Mech Med Biol, 18.02, 2018.
2. De la Rosa Castelo et al, The JPD,121.3, 2019