

Selection of Restorative materials and its impact on the stress transmission for total Implant supported fixed restorations, based on finite element methods

Mónica Arguedas, Mario Rodriguez, Valentina García

Department of Implantology, National Autonomous University of Mexico, Mexico City, Mexico



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BACKGROUND

Treatment of totally edentulous patient has been one of the most complex challenges in implant therapy, there are multiple treatment options, prosthesis schemes and restorative materials. The selection of definitive restorative materials is one of the fundamental aspects to achieve success, despite of this, in many cases this selection is based on the cost and on the recommendations of the dental technician without considering the biological and biomechanical aspects that are needed to make assertive choices. Metal-acrylic is one of the most used and recommended materials for total implant fixed restorations, because of this, the aim of this study is to set some guidelines for the selection of the restorative materials, based on its stress transmission properties, supported in finite element studies.

METHODS

This investigation was an in vitro study, based on finite element analysis. A computerized three-dimensional finite-element model of a human mandible with a fixed metal - acrylic denture supported by six osseointegrated implants (conic implant of 4x10mm) was created.

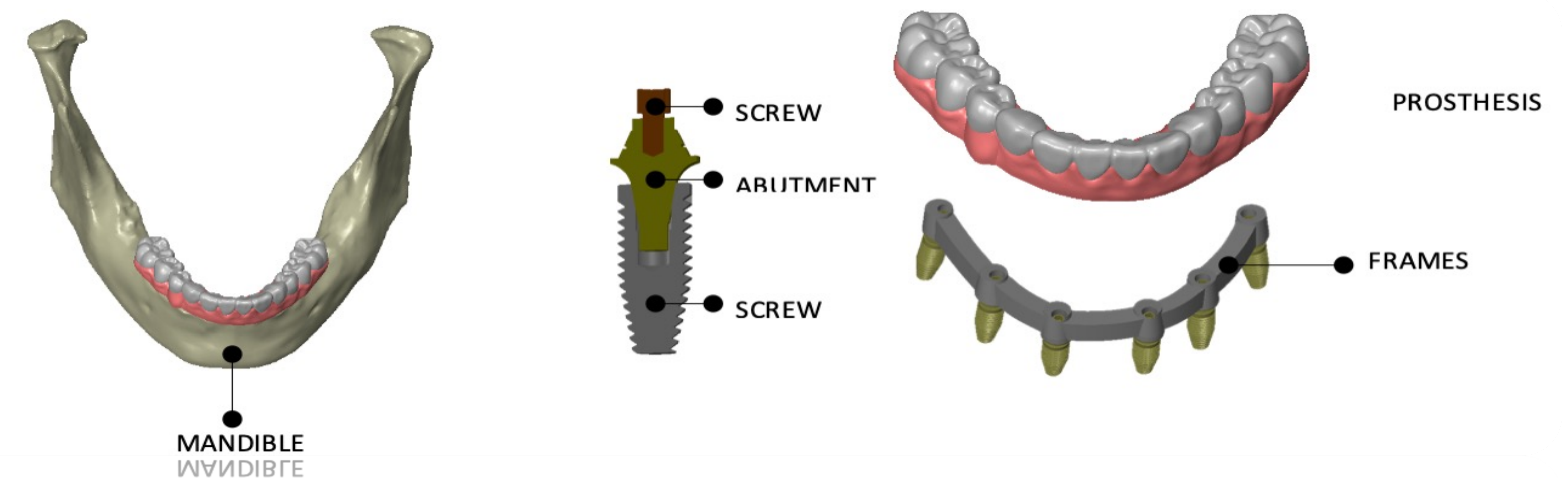


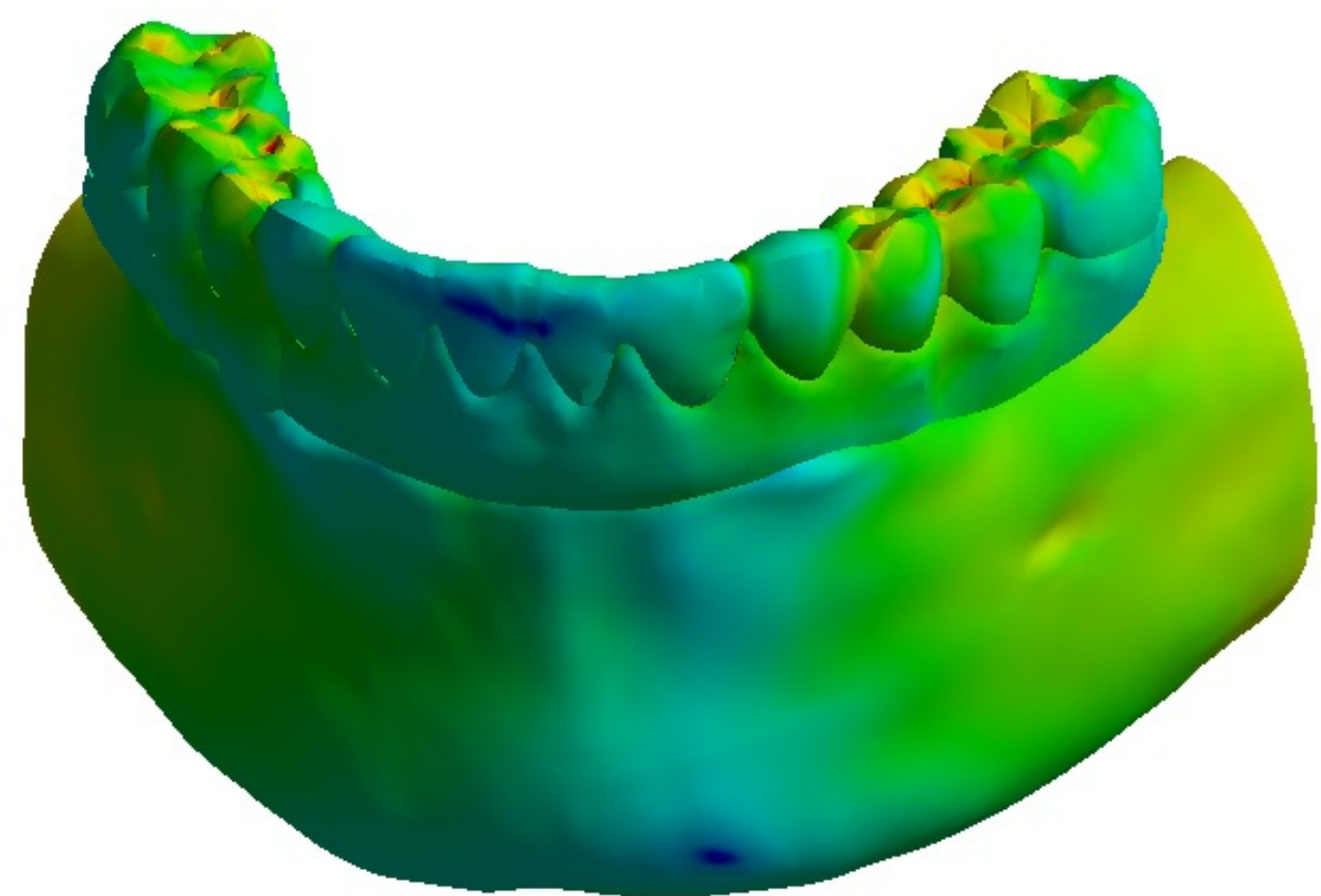
Figure 1: Geometric Model of an implant – supported prosthesis, using the technique all on six

RESULTS

MAXIMUM INTERCUSPATION

F: Máxima intercuspación
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 10:56 p. m.

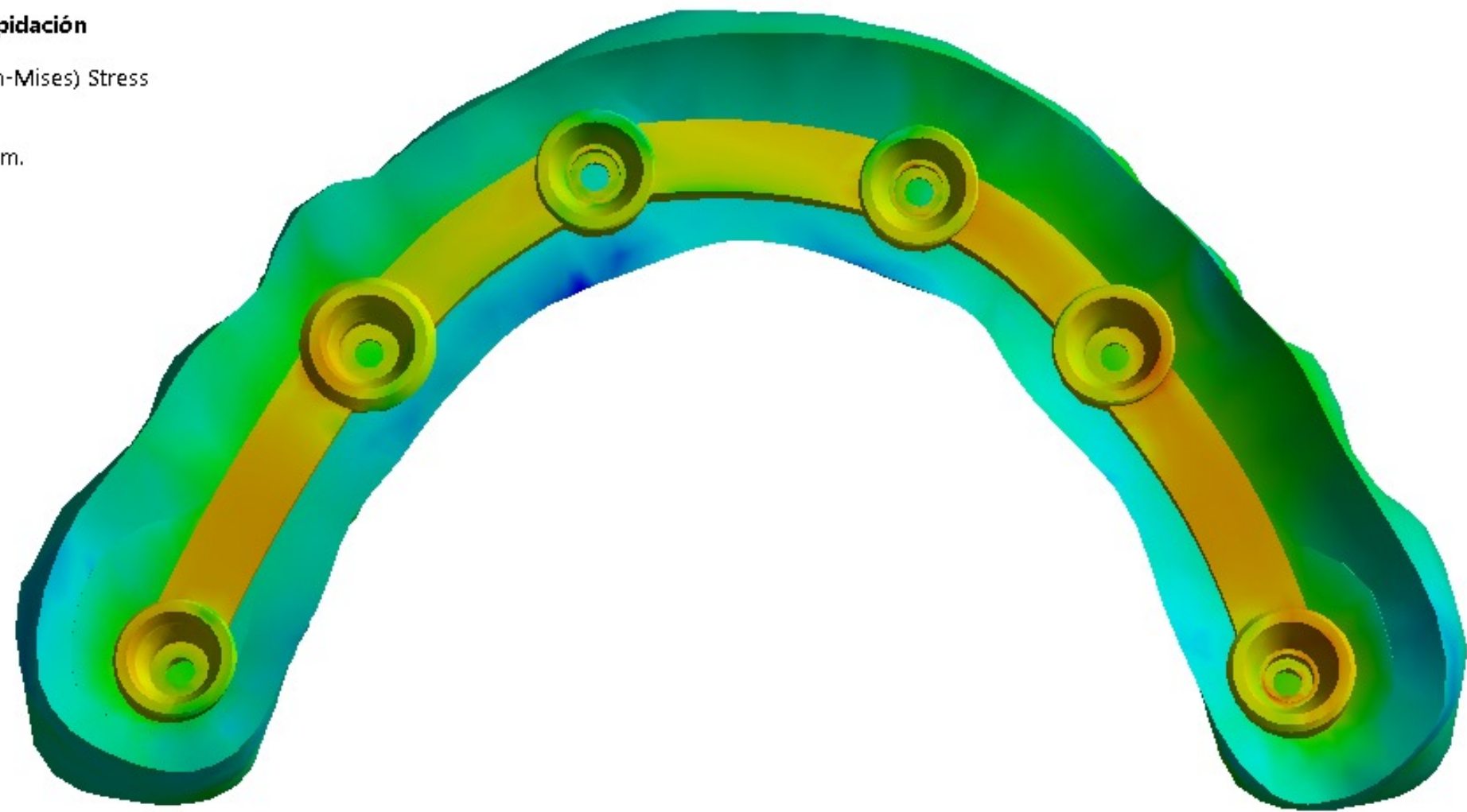
107.61 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0075426 Min



A

F: Máxima intercuspación
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 10:38 p. m.

107.61 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0075426 Min



B

F: Máxima intercuspación
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 10:37 p. m.

107.61 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0075426 Min

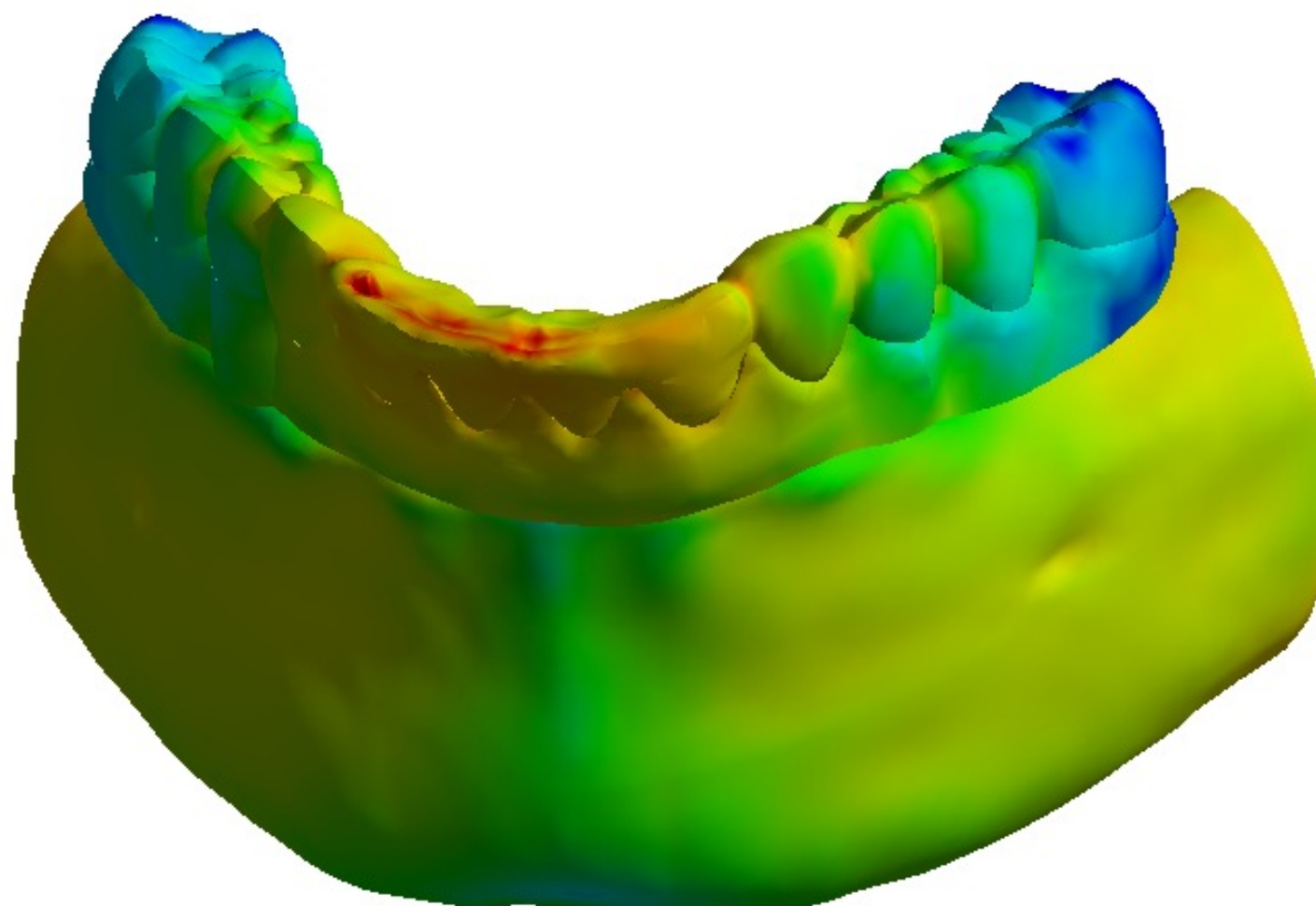


C

ANTERIOR GUIDANCE

G: Guía anterior
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 11:01 p. m.

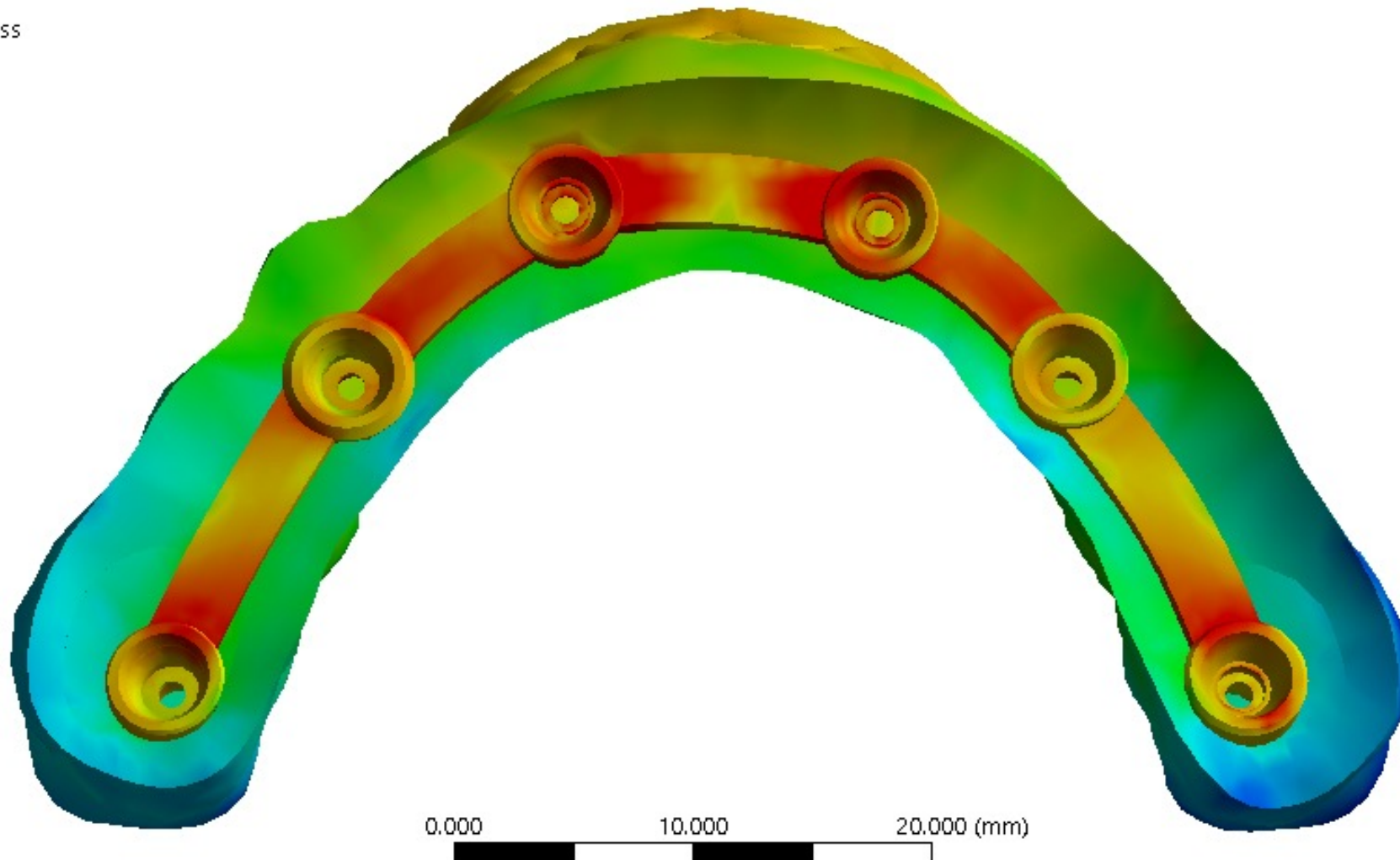
274.49 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0051454 Min



A

G: Guía anterior
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 11:03 p. m.

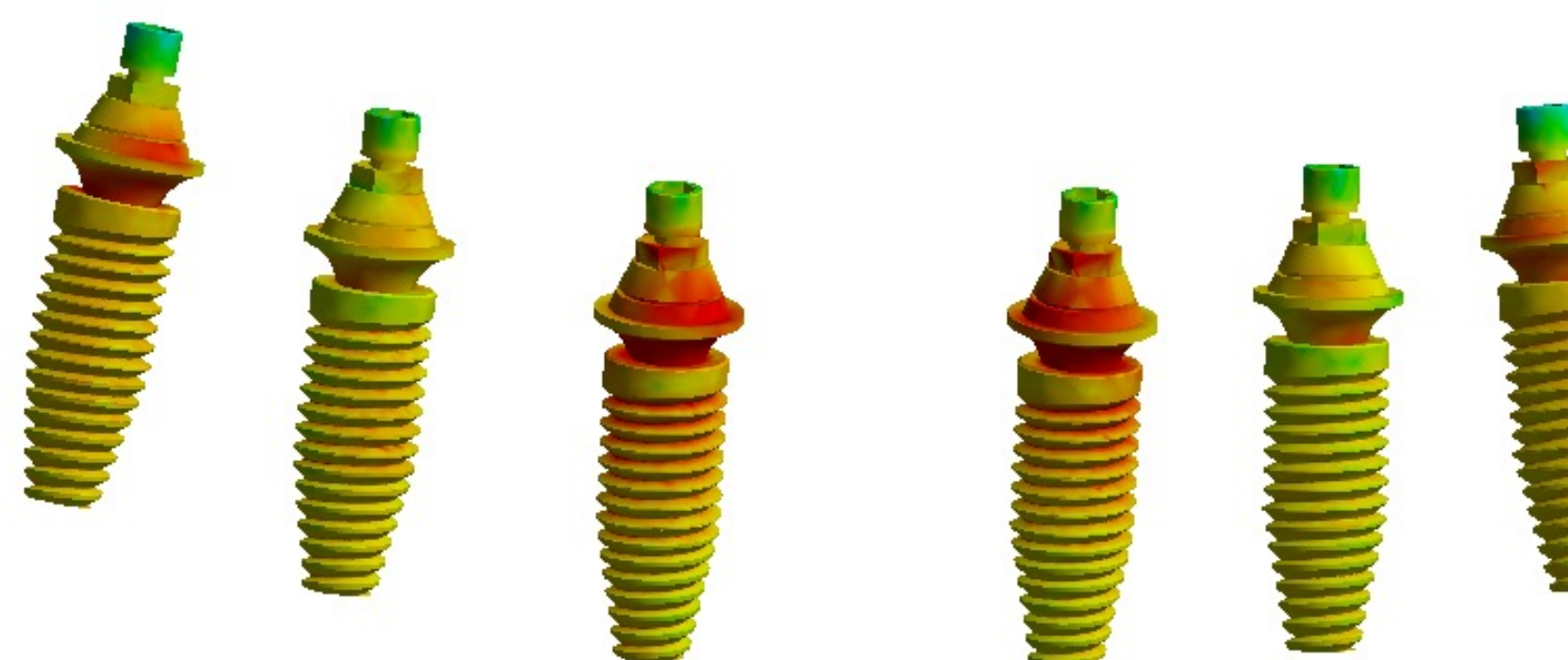
274.49 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0051454 Min



B

G: Guía anterior
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 11:03 p. m.

274.49 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0051454 Min

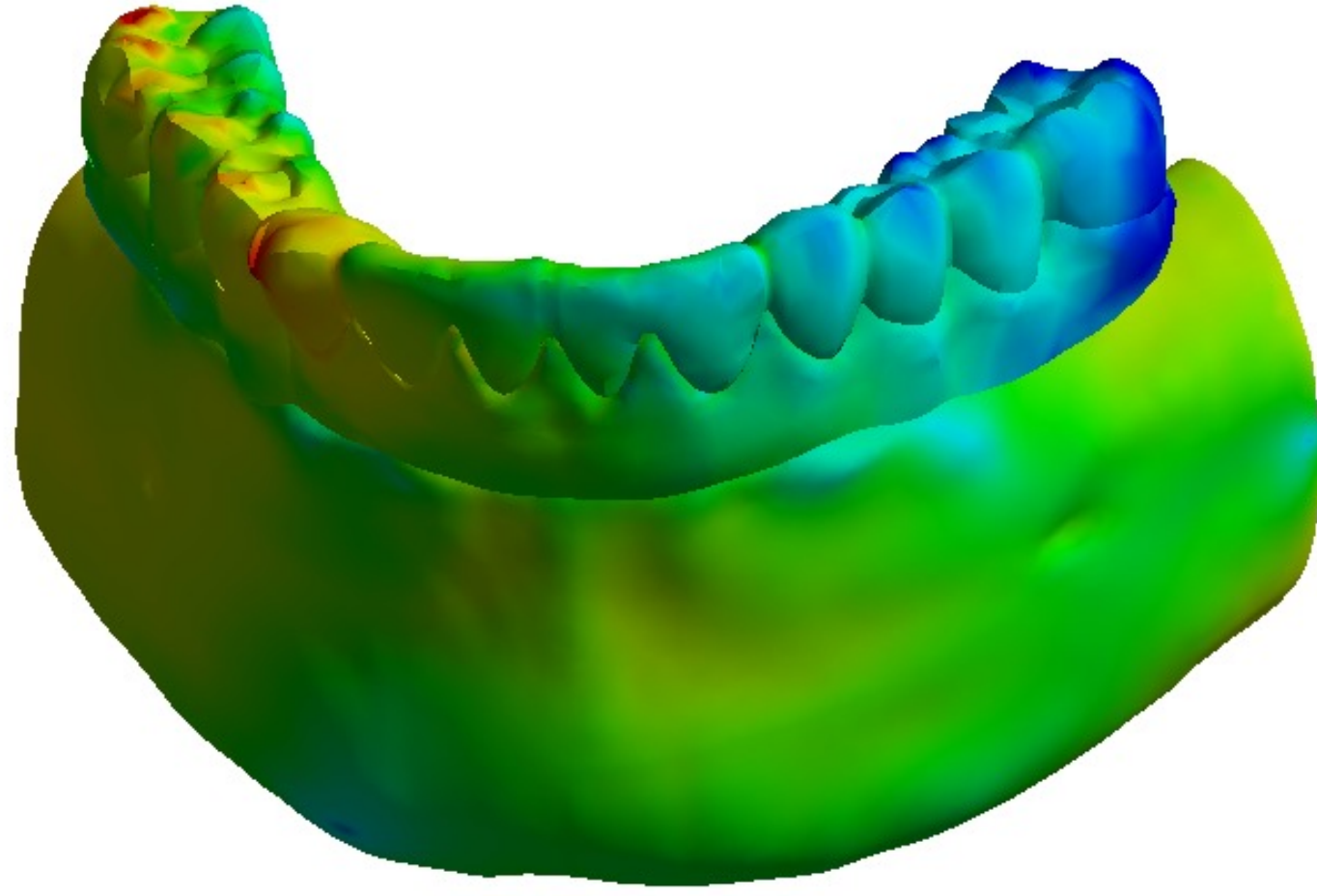


C

GROUP FUNCTION

H: Grupo funcion
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 11:10 p. m.

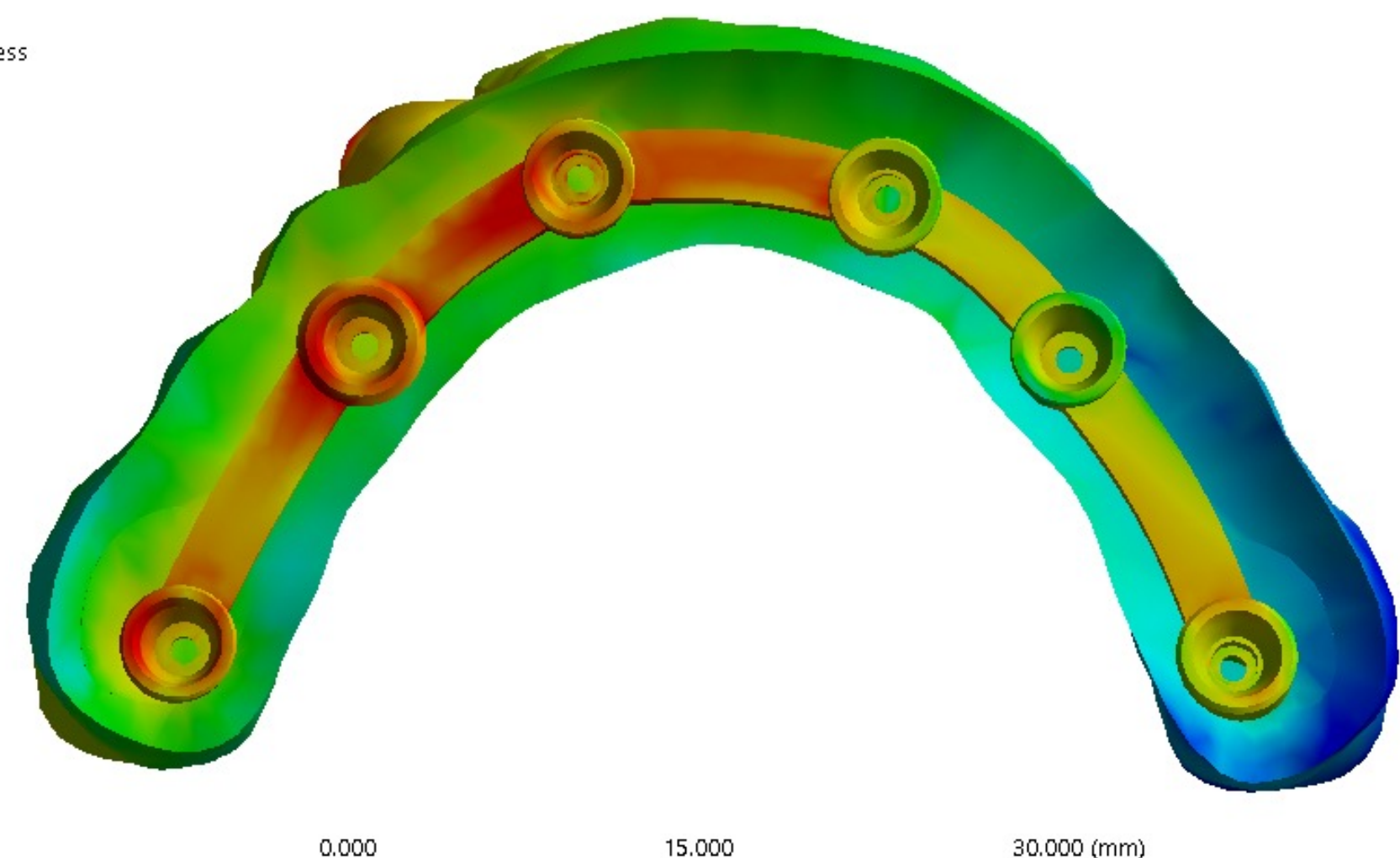
234.53 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0029996 Min



A

H: Grupo funcion
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 11:13 p. m.

234.53 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0029996 Min



B

H: Grupo funcion
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
19/01/2023 11:12 p. m.

234.53 Max
37.176
12.843
4.4368
1.5328
0.52953
0.18294
0.063198
0.021833
0.0029996 Min



C

Figure 2: Distribution of the stress in maximum intercuspation, anterior guidance and group function: A) Distribution of the stress over the fixed denture. B) Distribution of the stress over the implants C) Distribution of the stress over the bar

IMPLANT WITH INCREASED STRESS

IMPLANT WITH LESS STRESS

A. MAXIMUM
INTERCUSPATION

B. ANTERIOR
GUIDANCE

C. GROUP
FUNCTION

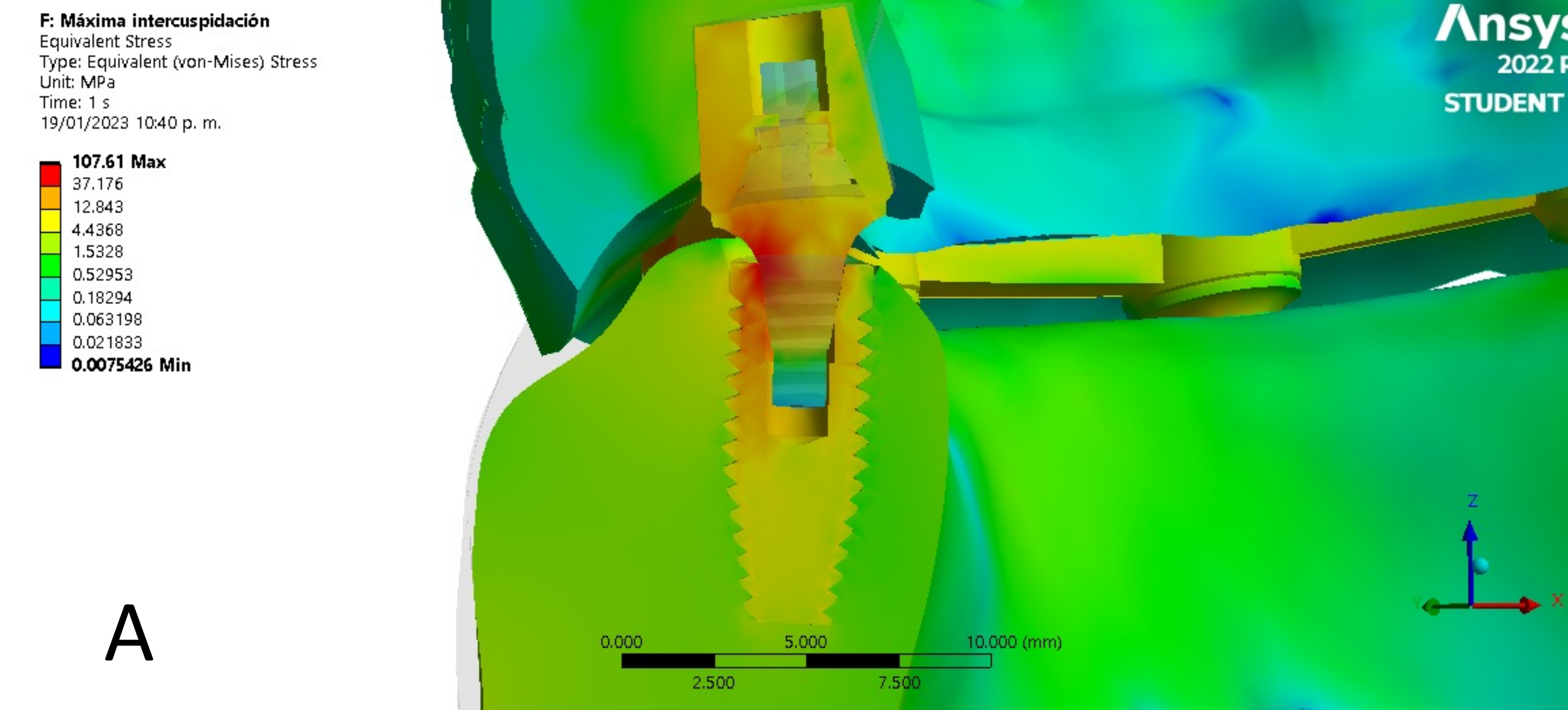
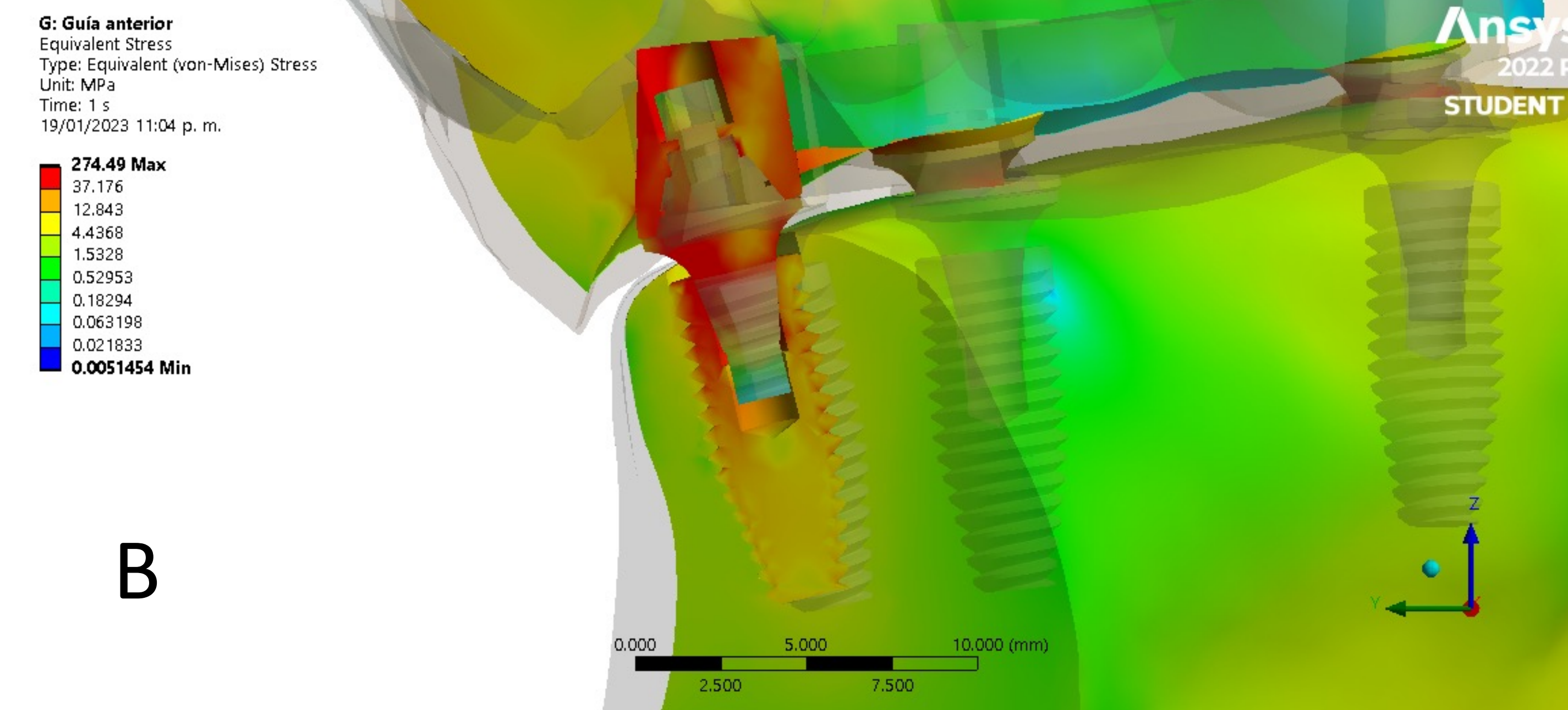
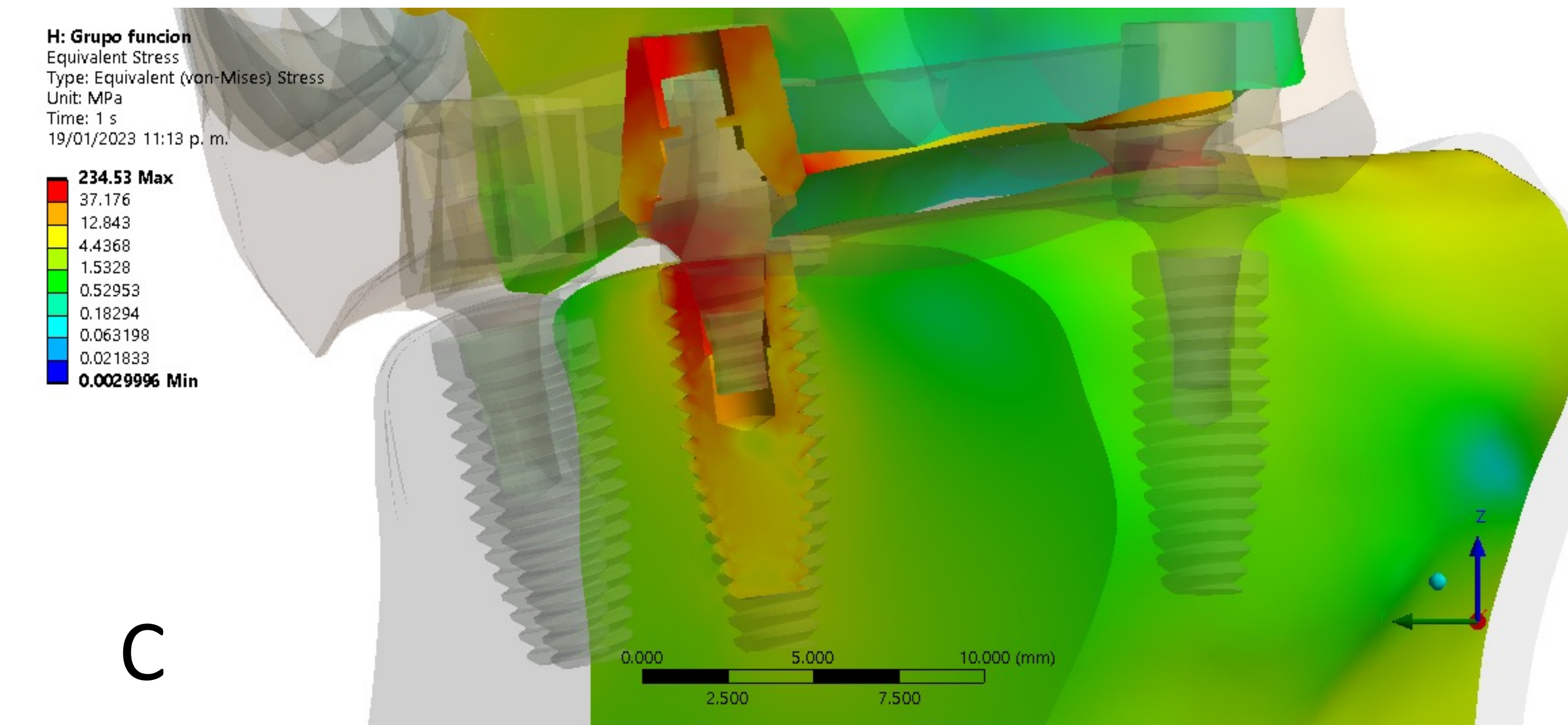
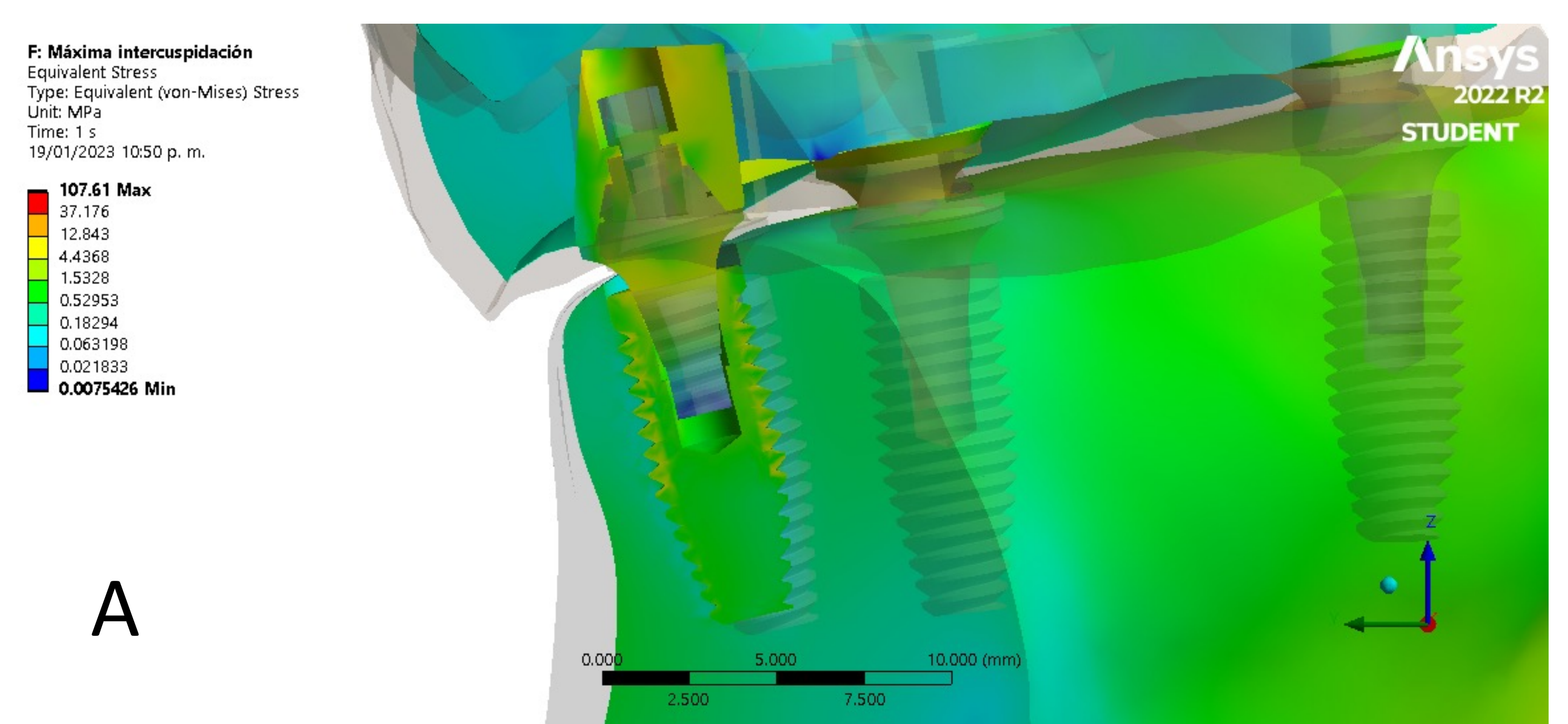
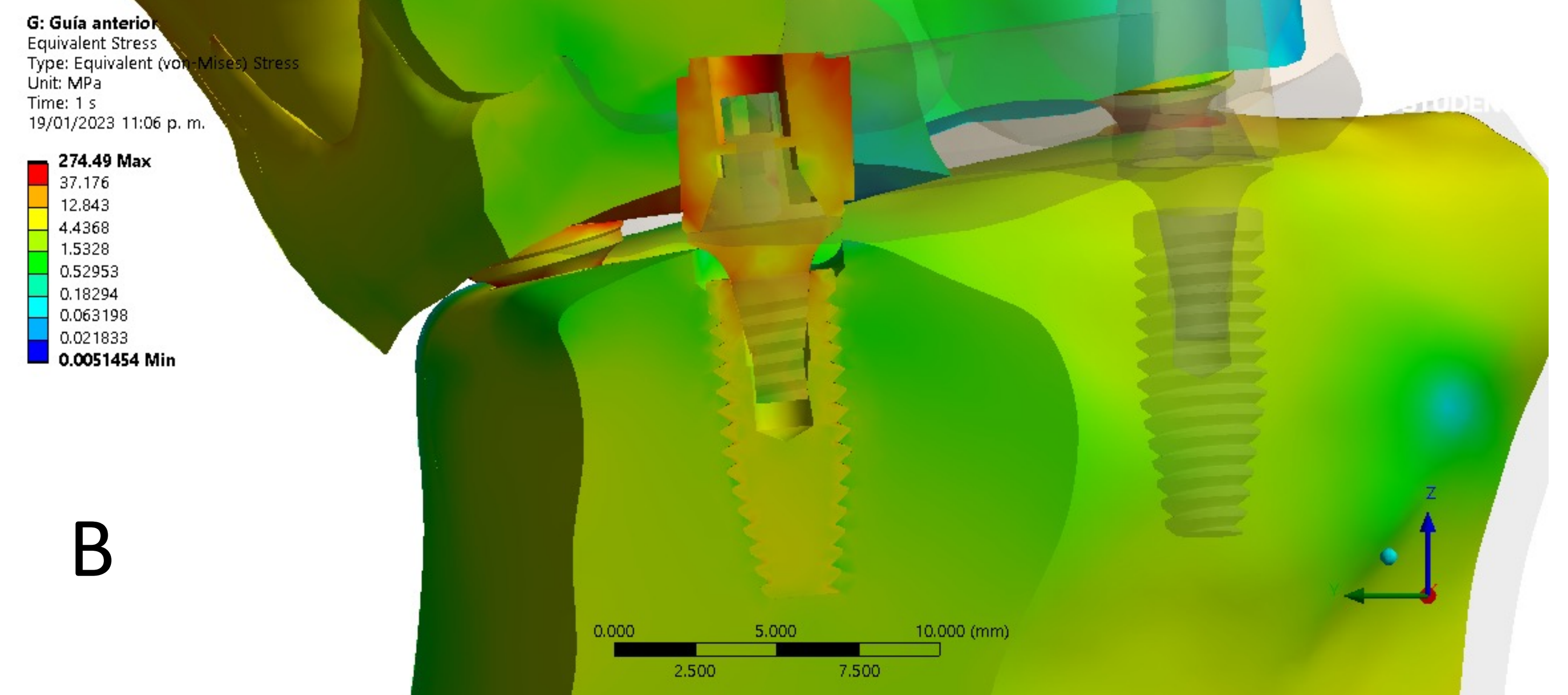
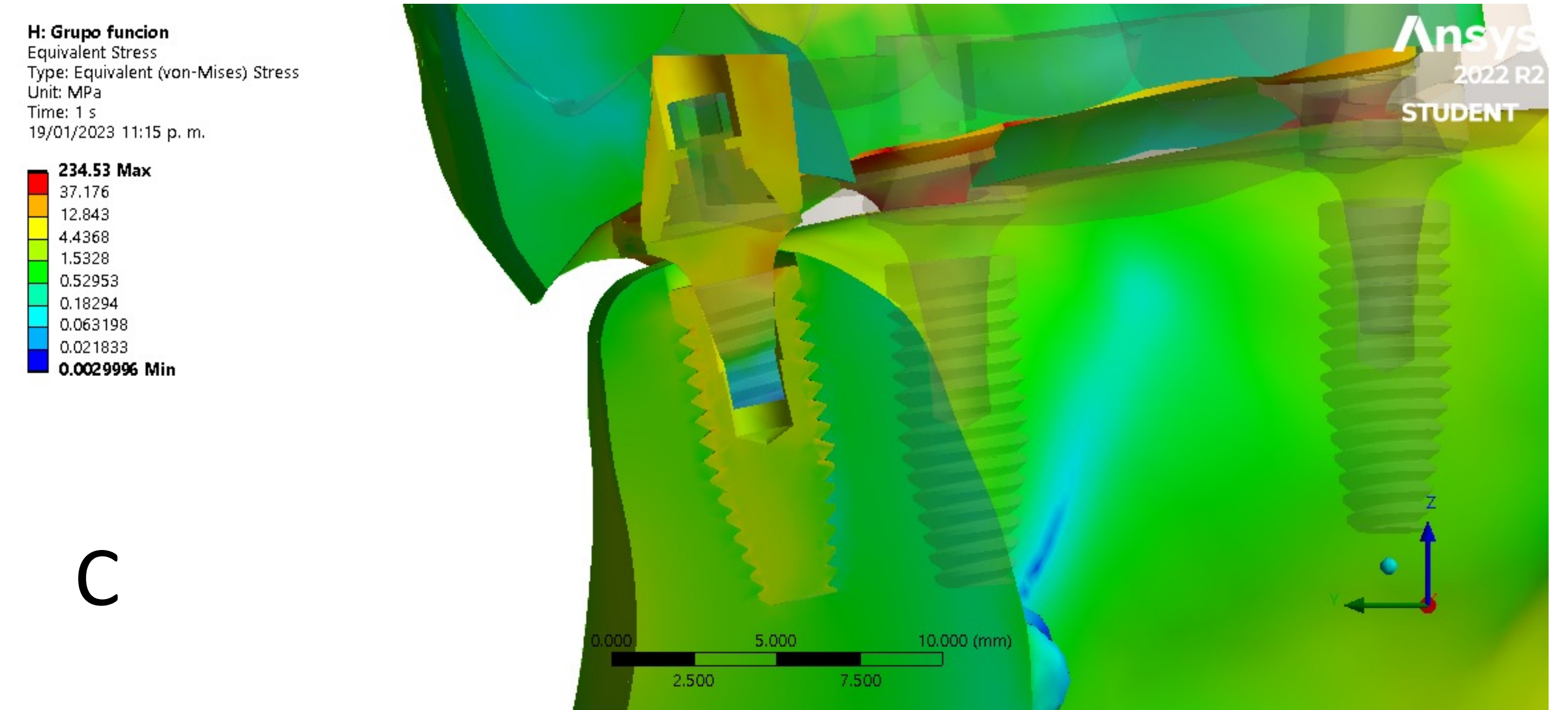


Figure 3: Sectional view of the implant with increased stress in A) Maximum intercuspation. B) Anterior guidance, and C) Group function

Figure 4: Sectional view of the implant with less stress in A) Maximum intercuspation. B) Anterior guidance, and C) Group function

CONCLUSION

In this study, finite element analysis allowed to determine the distribution of the load in a complete rehabilitation with a hybrid metal-acrylic prosthesis, during maximum intercuspation, anterior guidance and group function. During this 3 movements of the mandible, the distribution of the forces was observed in the expected areas.

Maximum intercuspation: homogeneous distribution is observed through the entire prosthesis and the Cr-Co bar.

Anterior Guidance: the greatest load is distributed in the anterior area.

Group function: on the working side a greater load is observed on the bar and homogeneously distributed towards the implants on that side.

Full acrylic metal prostheses over 6 implants is a good option to rehabilitate completely edentulous patients, in terms of the material's distribution of the load on the implants and the surrounding tissues.

Finite elements are a valuable tool for the simulation of loads in total implant supported fixed restorations, generating beneficial results for the clinician in its daily practice when selection the treatment plan for edentulous patients.

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to my teachers, Dr. Mario Rodriguez Tizcareño and Dr. Valentina García Lee for their invaluable academic and methodological scientific orientation, respectively. To my colleagues Dr. Edmundo Pacheco and Dr. Alberto Campuzano participating in this line of investigation. Also thank Benjamin Mancilla, dental technician, for his digital design for the investigation and the engineer Isaura Soto for the ANSYS processing and her orientation in the area of finite elements.

REFERECES



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