Dentistry – Fatigue test for endosseous dental implants

Report No.: 1
ASTRA System Ti Design

Client: NT - Trading

Time of execution: Mai 2011

Subject of work:

- S - 24613 Implant OsseoSpeedTM
- S - 24285 Abutment Ti DesignTM
- S – 800 Abutment NT-Trading

<u>RESULTS</u>

- See the attached pages –

Content:

Identification of the endosseous dental implant and its components

<u>S - 24613 Implant OsseoSpeed:</u>

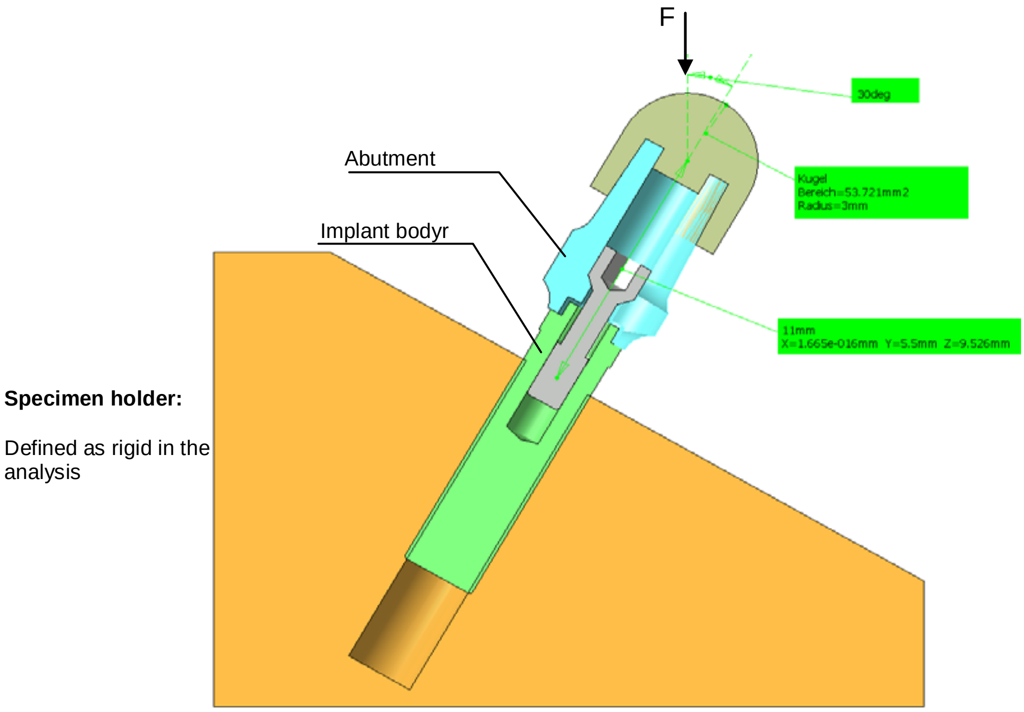
<u>S - 24285 Abutment TiDesign:</u>

<u>S – 800 Abutment NT-Trading:</u>

1.1. Test procedure

The test was performed in a worst-case scenario with the smallest available Abutment diameter listed in table page 5, according to the requirements of the international Standard ISO 14801 “Dentistry-Fatigue test for endosseous dental implants”. The test was set up and computed within an analytical FEA (Finite Element Analysis) tool. The Implant and the Abutments which were tested were selected to demonstrate the compatibility of the implant. S- 24613 Osseo Speed in combination with nt-trading S-800 Abutment.

Schematic diagram of fatigue testing.



The FE Analysis computes the stress distribution inside of a mechanical system, it displays the areas where the material deforms and therefore where it first collapses. Furthermore the Analysis delivers the actual force required for the strain of the system.

The Wöhler curve shows the fatigue behaviour of the material.

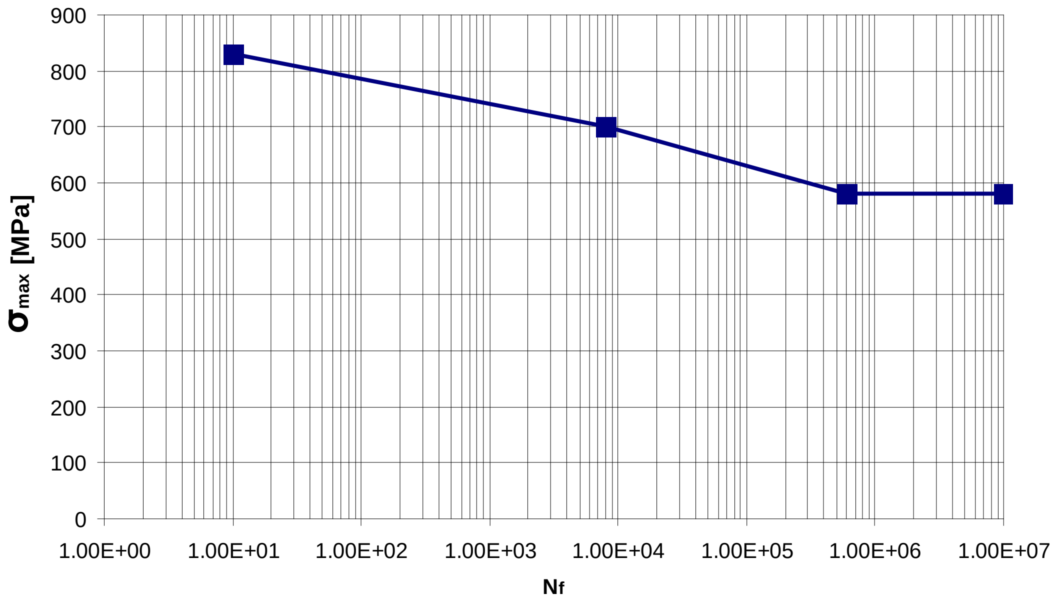


Fig. 1 Wöhler diagram: Ti6Al4V (Titan grade 5)

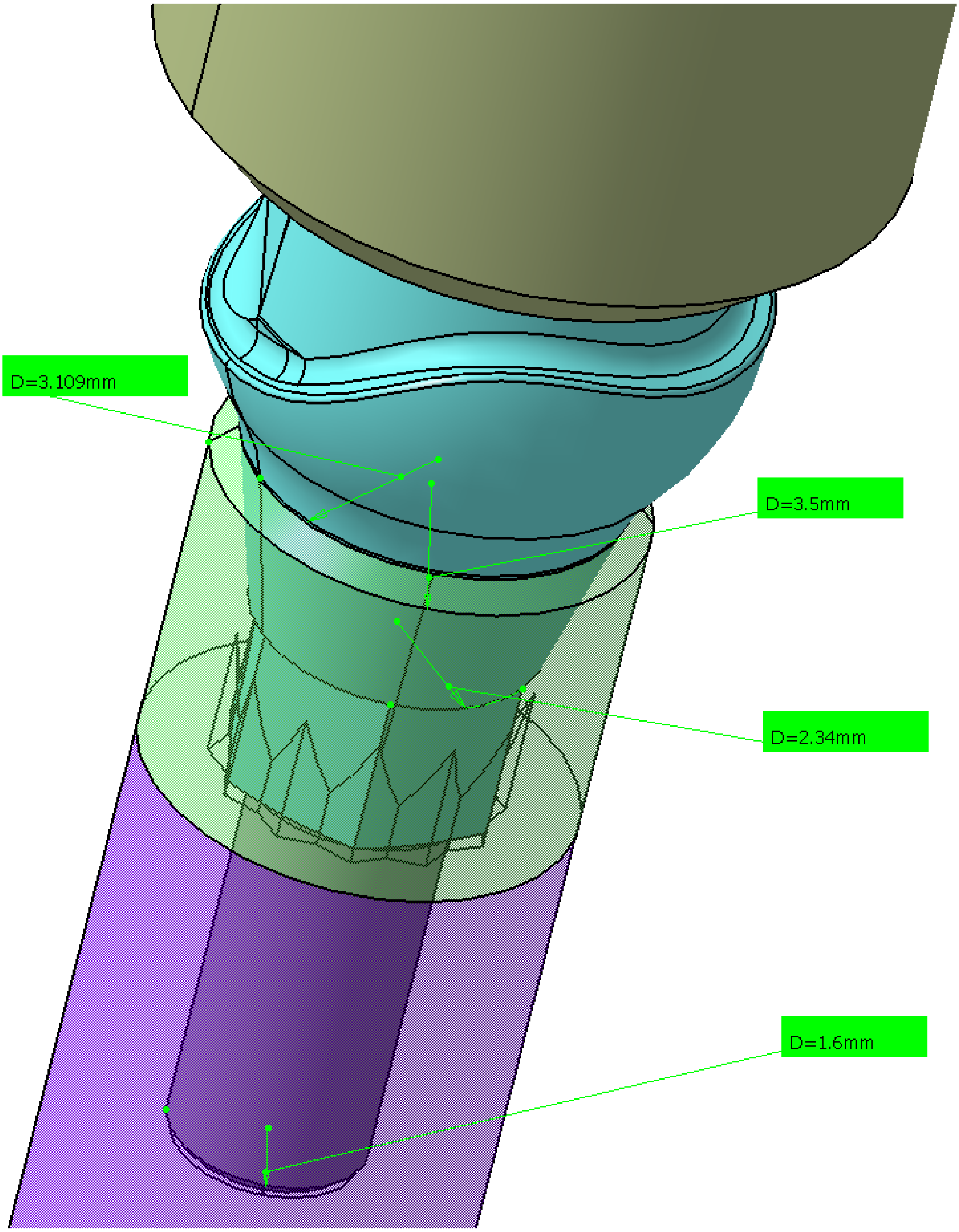
From the Wöhler diagram, the fatigue limit of the material can be determined, being the maximum stress for which fatigue does not occur even at an infinite number of loading cycles or at the number of cycles, N_f, selected for termination of each test that does not result in failure.

Thus stress distribution, computed from the FE Analysis, may not exceed a certain level that the system endures 5×10^6 cycles. As mentioned above the stresses are induced by a force applied on the system, and as a result you get the value of bearable force for the system.

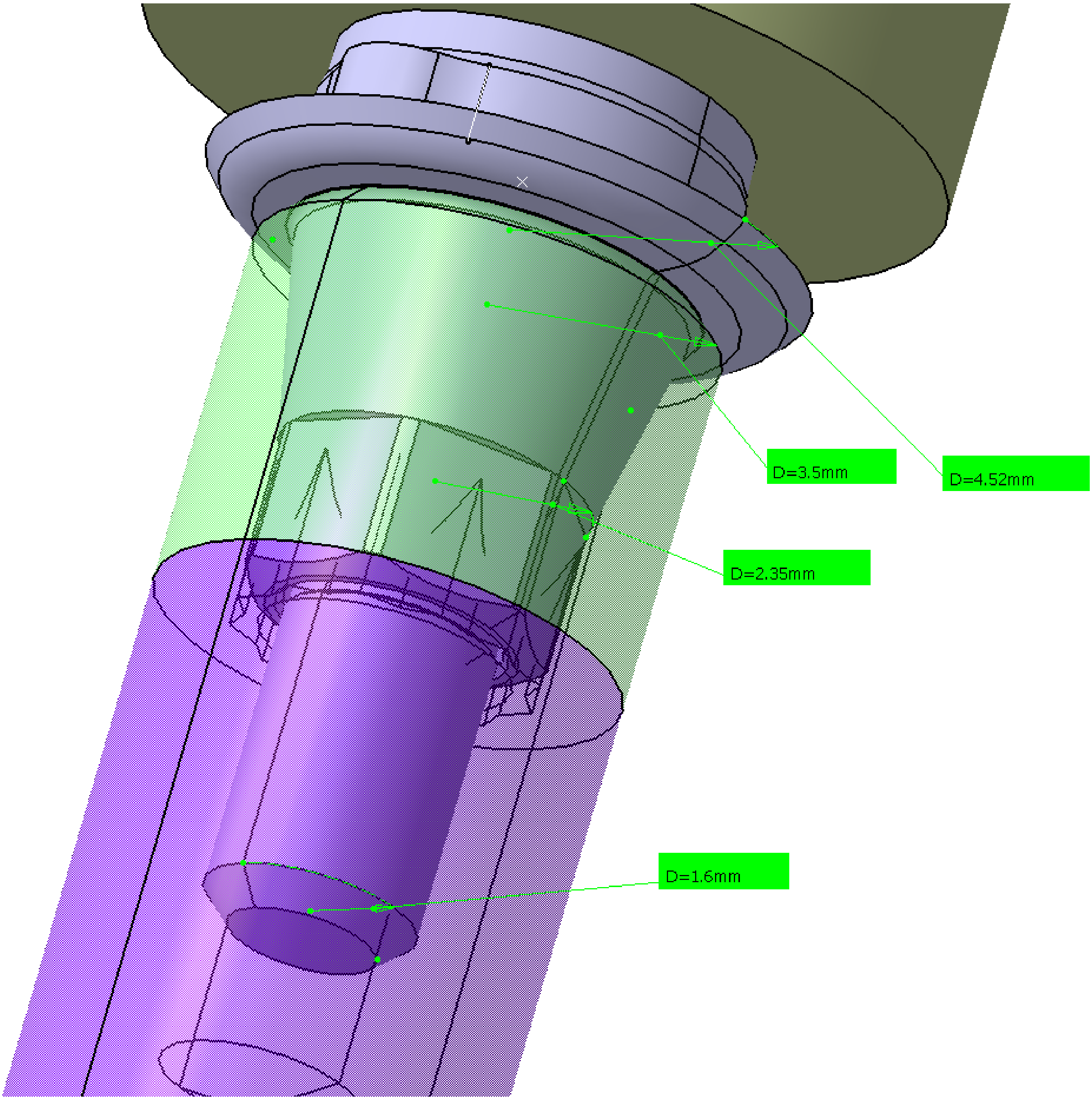
	S - 24613 Implant OsseoSpeed	**S - 24285 Abutment TiDesign**	**S – 800 Abutment NT-Trading**
Type of endosseous dental implant body (e.g. threaded, tapered, cylindrical)	screw-shaped implant with a defined surface roughness	-	-
Type of connecting part(s) (e.g. screw-retained, ce-mented, taper-fit, cylindrical, conical)	-	Conical	Conical
Manufacturer	ASTRA TECH AB P.O. Box 14 SE-431 21 Mölndal, Sweden	ASTRA TECH AB P.O. Box 14 SE-431 21 Mölndal, Sweden	NT Trading
Material(s) of the tested parts, including any coating material(s) and other surface treatments	Commercially pure titanium, grade 5	Commercially pure titanium, grade 5	Commercially pure titanium, grade 5
Diameter and length of the endosseous dental implant body	Diameter: 3,5 mm Length: 13,0 mm	-	-

2. Geometric dimensions

S - 24285
Abutment TiDesign



S – 800
Abutment NT-Trading



3. Results

3.1. Maximum endurable load at 5 × 10^6 cycles or, for tests at frequency of 2 Hz, 2 × 10^6 cycles (fatigue limit) and Nominal bending moment for the maximum endurable load

	Maximum endurable load	**Nominal bending moment for the maximum endurable load**	**Load where first signs of plastic deformation appears**
S - 24613 Implant OsseoSpeed / S - 24285 Abutment TiDesign	278 N	1.53 Nm	449 N
S - 24613 Implant OsseoSpeed / S – 800 Abutment NT-Trading	372 N	1.36 Nm	620 N

3.2. FEA Conclusion, Description and Explanation respective to the test report.

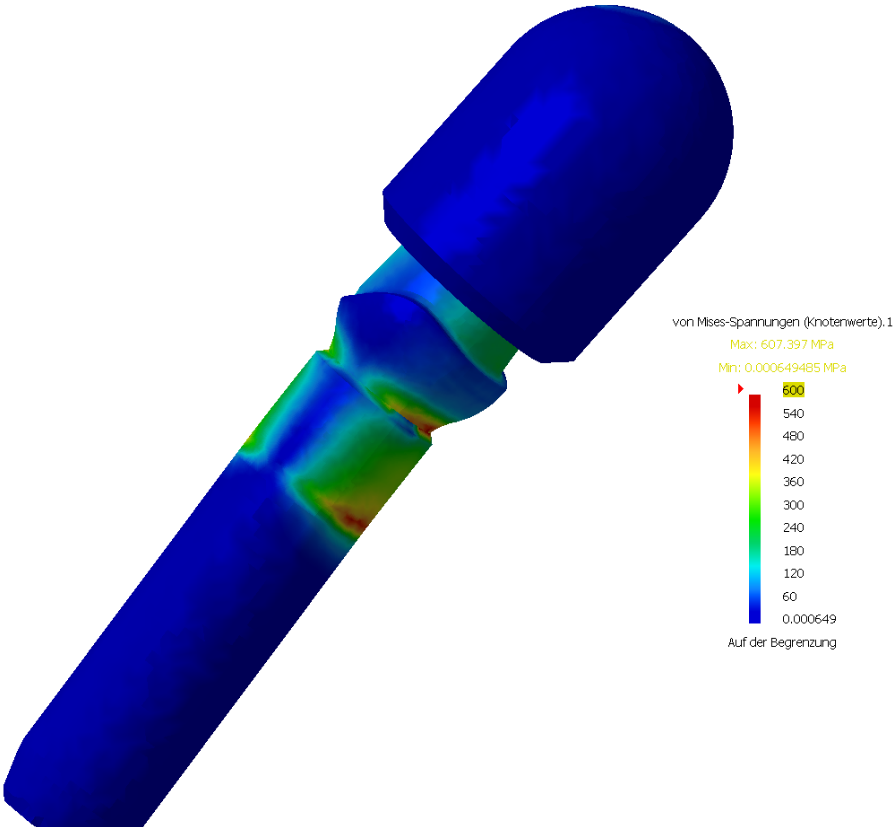
One of the vital factors in the dental implant design process is to investigate the fatigue behaviors. In this Test Report, a three-dimensional finite element analysis model was performed to investigate the fatigue behaviors of implant and nt-trading abutment combination. Fatigue test was done in order to prove the reliability of proposed combination.
It was shown that computational modeling and 3D simulation using finite element analysis enabled the realistic prediction of dental implant fatigue behavior.

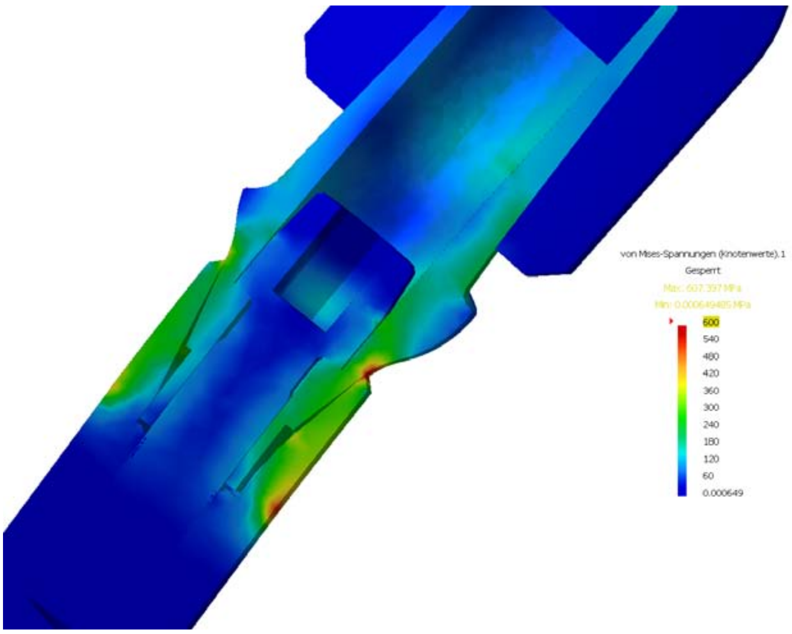
Result from the fatigue analysis meet the ISO Standard and shows that the nt-trading abutment design can be used as a compatible endosseous dental implant / abutment solution. The implant / abutment fatigue life simulation result shows that S – 24613 Implant OsseoSpeed and nt-trading abutment combination would achieve fatigue limit of 5 x 106 cycle suggested by the ISO at 372 N.

The location of the fatigue failure in the implant system was estimated with a high accuracy in the simulation. As shown in Figure “S – 24613 Implant OsseoSpeed / S – 800 Abutment NT-Trading”, the computer simulation data showed high concentration of stress in the possible region of fatigue fracture.
Considering the maximum voluntary bite force of human incisor is about 150 N, this suggests that the S – 24613 Implant OsseoSpeed and nt-trading abutment combination can be used as a reliable dental implant abutment solution.
A comparison of the physical fatigue test with FEA fatigue test displayed the accuracy and reliability of the computer simulation method.

Description and location of critical failure point for each test specimen

<u>S – 24613 Implant OsseoSpeed / S – 24285 Abutment TiDesign:</u>





<u>S – 24613 Implant OsseoSpeed / S – 800 Abutment NT-Trading:</u>