

Application News

No.i252

Material Testing System

Orthodontic Implant Fatigue Testing

■ Introduction

Dental implantation normally refers to a method of treatment that involves embedding a titanium implant in the jaw bone and fitting an artificial tooth onto this implant to return the function and aesthetic appearance of the original tooth. Orthodontic implantation uses implant technology to affix artificial material into bone. Embedding artificial material into bone has advantages of orthodontic therapies that use implants, such as being able to secure a stronger anchor, increasing the range of movement of the teeth, increasing the likelihood of using therapies that do not require tooth removal, and increasing the scope of non-surgical orthodontic therapy. However, fluoride solutions used in mouthwash can have a negative effect on the durability of titanium implants. Consequently, fatigue testing of orthodontic implants must be performed in solution so its effect can be determined and more durable orthodontic implants developed. We performed fatigue testing of an orthodontic implant in pure water at 37 °C, and report the results.

■ Measurement System

The Electromagnetic Force Fatigue and Endurance Test System MMT-101NV-10 was used for testing. Testing was performed in pure water at 37 °C using a thermostatic water immersion test unit. Testing was performed as shown in Fig. 1, and the test equipment used is shown in Table 1.

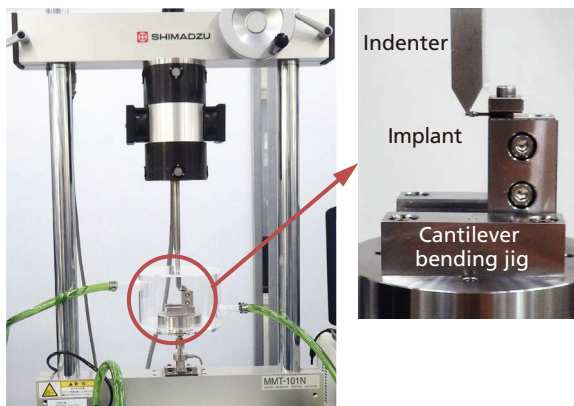


Fig. 1 Test Overview

Table 1 Experimental Equipment

| | |
|-----------------|--|
| Testing machine | : MMT-101NV-10 |
| Load Cell | : 100 N |
| Jig | : Implant cantilever bending jig |
| Tank | : Thermostatic water immersion test unit |

■ Results

(1) Static testing

First, static testing was performed to determine the loading level for fatigue testing. Test conditions are shown in Table 2, and the static test results are shown in Fig. 2. Based on static test results, the mean maximum strength was 35.4 N.

Table 2 Test Conditions

| | |
|------------------|----------------------------|
| Testing Speed | : 5 mm/min |
| Test Environment | : Room temperature, in air |
| Number of Tests | : n = 5 |

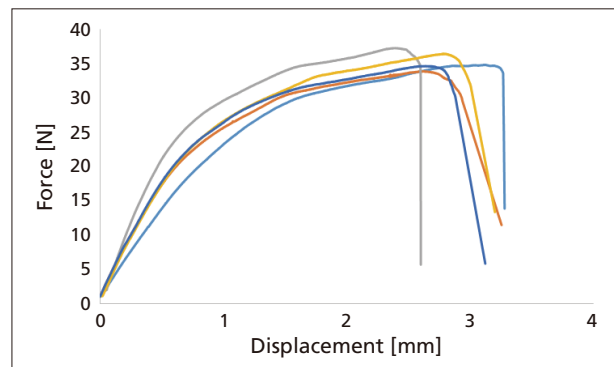


Fig. 2 Results of Static Testing

(2) Fatigue testing

The loading level for fatigue testing was determined based on the static test results. The test conditions used in fatigue testing are shown in Table 3.

Table 3 Test Conditions

| | |
|----------------------------|---|
| Max. Force | : 30, 25, 20, 15, 12.5, 11, 10, 9, 8, 7 |
| Stress Ratio | : 0.1 |
| Frequency | : 10 Hz |
| Test Environment | : 37 °C, in pure water |
| Max. Number of Repetitions | : 5,000,000 |
| Number of Tests | : n = 1 |

Test results are shown in Fig. 3. Fig. 3 shows that at a maximum force ≤ 11 N the number of cycles to failure was $< 10,000$, and there was no particular increase in the number of cycles to failure. At test forces ≤ 10 N, the maximum force fell and the number of cycles to failure increased substantially. At a maximum force of 7 N, failure did not occur at $< 5,000,000$ cycles.

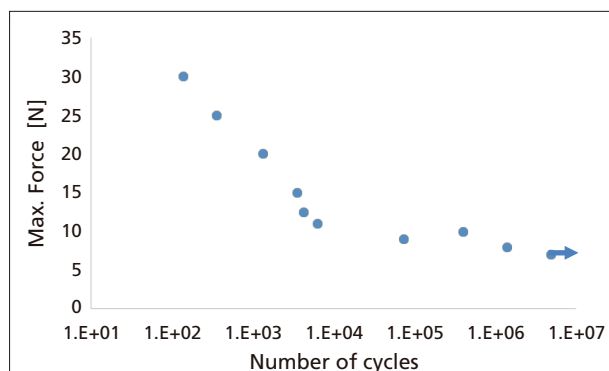


Fig. 3 S-N Curve

Conclusion

We performed cantilever bending fatigue testing of an orthodontic implant at 37 °C in pure water. The orthodontic implant we tested had a small number of cycles to failure at maximum forces ≥ 11 N (≥ 31 % of static strength), but this number of cycles to failure increased at forces ≤ 10 N (≤ 28 % of static strength). We plan to perform more fatigue testing in fluoride compound-containing mouthwash solution. This report shows that Shimadzu's test system can be used to perform cantilever bending fatigue testing of orthodontic implants in solution, and may be used for the development and evaluation of orthodontic implants.