Introduction
Carpal tunnel syndrome is an entrapment neuropathy that is caused by compression of the median nerve due to a variety of reasons. Symptomatic pain and tingling sensations are clinical problems and caused by compression of the narrow sensory nerve fiber groups. The Phalen test has been one of the most significant of clinical signs when making a clinical diagnosis of carpal tunnel syndrome and checking the progress of this condition since Phalen modified the test in 1966. It is generally believed that median nerve compression is caused by the surrounding tissues when the wrist is flexed, thus resulting in the onset of pain and tingling sensations. However, it remains unclear exactly how the median nerve are affected by the Phalen test in vivo. Therefore, it is interesting to study to what extent blood flow is disturbed in the median nerve when pain and tingling sensations are experienced in carpal tunnel syndrome. In this study, an intraoperative Phalen test was performed, with attention given to pain and tingling sensations experienced during the Phalen test. In the Phalen test performed intraoperatively, we evaluated the extent of the intraneurial blood flow disturbed, which caused pain and tingling sensations to develop, using a laser Doppler blood flow meter.

Methods
The subjects were 15 patients with carpal tunnel syndrome who underwent carpal release (3 men and 12 women, aged 62.9 years on average [range, 41-78]). The preoperative Phalen test revealed that 10 patients experienced pain and tingling sensations. First, we confirmed that the median nerve were compressed by the transverse ligament by observation under a naked eye. Then, a needle-type sensor of the laser doppler flow meter was pierced into the median nerve in the transverse ligament, and then performed an intraoperative Phalen test by flexing down the patients’ wrist on the affected side and kept at that position for 1 minute to determine the change in intraneural blood flow. The details of the test were explained to the patients in obtaining their informed consent in advance. The test was performed only on those who gave consent. The blood flow immediately after the test was used as the baseline measurement, with the values obtained during and just after the test being expressed as a percentage of baseline and are presented as the mean ± SEM. Comparison of values was performed using Student’s t-test.

Results
The intraoperative reverse Phalen test showed that the narrowing carpal tunnel caused median nerve compression in all patients. During the Phalen test, there was a sharp decrease of intraneural blood flow at the angle at which pain and tingling sensations were experienced in all the patients, and this decrease lasted during the minute of Phalen test. Intraneural blood flow had decreased by 2.1–48.7% (average±SEM: 24.8±13.2%) and 0–43.3% (21.4±13.0%) at 20 and 50 seconds after initiating the test, respectively. When the angle of the legs was retuned to zero degrees, which pain and tingling sensations were experienced in all the patients, and tunnel caused median nerve compression in all patients. During the Phalen test performed intraoperatively, we evaluated the extent of the intraneurial blood flow disturbed, which caused pain and tingling sensations to develop, using a laser Doppler blood flow meter.

Discussion
The Phalen test is a test by which compression is loaded to the median nerve. Narrowing carpal tunnel, which was caused by transverse ligament, resulted in compression of intraoperatively found transverse ligament to the median nerve, disturbing gliding of the median nerve, thus contributing to an increase in compression given to the median nerve by transverse ligament. When pain and tingling sensations was experienced during the Phalen test, transverse ligament caused relatively strong acute compression to the median nerve, resulting in around 70-80% decrease (on average) in intraneural blood flow. It was predicted that disturbed blood flow caused by this mechanical stress led to development of edema and anoxemia, constituting an inductive factor of ectopic discharge responsible for pain.

Conclusion
This study demonstrated that the blood flow in the median nerve is reduced when the median nerve is compressed in vivo.

References

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