INTRODUCTION: The repetitive motion related to the activities of sports athletes and industrial workers is one of the risk factors for the entrapment neuropathy. Therefore, to clarify the pathophysiologic mechanisms of incipient neuropathy by repetitive stress, we invented a novel compression apparatus. The objective of this study is to investigate the differences in response to repetitive compression versus constant compression in physiologic aspects.

METHODS:
Surgical Procedure
Our experimental protocol was reviewed and approved by the animal studies subcommittee of Tsukuba University. Twenty-four adult male Japanese white rabbits weighing approximately 3.0 kg each were used. The special apparatus was designed to put a nerve segment under varying controlled pressures making it possible to apply the compression periodically. Under anesthesia, the sciatic nerve was explored at the mid thigh level and the apparatus was set around the nerve. We selected 80 mmHg as the compression force. This pressure was determined in a previous study in which nerve conduction and blood flow recovered rapidly after 30 minutes of brief compression. Four conditions of compression were each applied for 90 minutes, namely, continuous compression (CC); low frequent release compression (LFR), pressure applied with 1 second release time every 30 seconds; high frequent release compression (HFR), pressure applied with 1 second release time every 10 seconds; high frequent compression (HFC), pressure applied 1 second every 10 seconds (Fig.1).

Electrophysiological analysis
Compound nerve action potential (CNAP) was recorded at the peroneal nerve which was distal to the compression site. The proximal sciatic nerve was stimulated. CNAP was recorded every 10 minutes from the start of compression to 90 minutes after compression release. CNAP was evaluated in terms of its amplitude, latency, and duration, and the ratio with respect to the initial state was compared among the groups.

Evaluation of intraneural microvascular permeability
Nerve blood flow (NBF) was recorded using a laser Doppler flowmeter (ALF21R, Advance Co., Tokyo, Japan) at the compression site. Blood flow was continuously monitored and recorded from 10 minutes before compression to 90 minutes after compression release. The average of the first 10 minutes’ data was used as the initial state, and the ratio of each 10 minute average with respect to the initial state was compared among the groups.

Statistical analysis
One factor ANOVA followed by Fischer’s PLSD post hoc test was chosen for analyzing differences. Significant differences were defined by P<0.05.

RESULTS:
Electrophysiological changes (Fig. 2)
CNAP amplitude gradually decreased with compression (60.8, 76.7, 80.7, and 88.8% at 90 minutes of compression in the CC, LFR, HFR, and HFC groups, respectively). After compression release, although the CC group showed rapid recoveries of CNAP amplitude, the repetitive groups did not show full recovery. Latency and duration did not show marked changes.

Evaluation of nerve blood flow (Fig. 3)
Nerve blood flow decreased with compression immediately in the CC, LFR and HFR groups. HFC group showed gradual decrease. After compression release, although the CC group showed rapid recoveries of nerve blood flow, the repetitive groups did not show full recovery.

RESULTS:
Each of the repetitive groups showed leakage of EBA at compression site. CC group did not show leakage of EBA.

DISCUSSION: This study demonstrated that the nerve responded differently to different repetitive compression conditions. The repetitive compression groups showed a delay in recoveries of CNAP and NBF after compression release. Moreover, endoneurial edema was induced rapidly. These results suggest that repetitive compression may affect the nerve after compression release with collapse of the blood nerve barrier.

Fig.1: Compression conditions.

Fig.2: Changes of CNAP amplitude (mean±S.E.).

Fig.3: Changes of nerve blood flow (mean±S.E.).

ACKNOWLEDGEMENTS: This research was supported by a grant from the Japan Society for the Promotion of Science (JSPS, no.17659459).