INTRODUCTION: The current clinical repair method for a segmental peripheral nerve defect is autogenous nerve grafting. However, because of the disadvantages associated with autogenous nerve grafting, an alternative method is desirable. The repair after lengthening of nerve stumps could be one of alternative methods. Our previous studies have shown that the repair of the peripheral nerve defect with direct lengthening of either a proximal nerve stump or a distal nerve stump results in successful nerve regeneration similar to nerve grafting (1, 2). Therefore, lengthening of both nerve stumps might be a more beneficial for the repair of a larger nerve defect. So, we investigate whether the direct gradual lengthening of both nerve stumps is feasible for the repair of a segmental peripheral nerve defect.

MATERIALS and METHODS:
Surgical Procedure
Thirty-six adult Wistar rats were used. The rats were maintained according to the requirements of the ethics committee of University of Tsukuba. A nerve segment 15 mm in length was resected from the sciatic nerve in each animal under the anesthesia. In the nerve lengthening group (Fig 1), the proximal and distal nerve stumps were fixed to the ring with 2-0 nylon suture respectively. The traction sutures (3-0 polyester sutures) which attached to the ring were bound to the external fixator for nerve distraction. The both stumps were distracted via the traction sutures from the next day of the operation under the anesthesia. The distraction was performed at a rate of 1 mm / day. After the distraction of 14 days, both stumps were refreshed and a direct end-to-end anastomosis was performed. For the control, the autogenous nerve-grafting procedure was performed in which the resected nerve segment in 15 mm length was implanted immediately in reverse direction (nerve grafting group, Fig 2).

Fig 1. Nerve lengthening group
Fig 2. Nerve grafting group

Evaluation of nerve regeneration
At 6, 8, 14 weeks after the first operation, nerve regeneration was evaluated in both groups (n=6, each). At 8 and 14 weeks, nerve conduction velocity and tetanic contraction force and wet weight volume of gastrocnemius muscle were evaluated. The data were expressed as a percentage of the contralateral. At 6, 8, and 14 weeks, a nerve segment was resected from the tibial nerve at 5 mm proximal to entrance into the gastrocnemius muscle and a 1-μm transverse section was made. The mean fiber density and the mean axonal diameter were analyzed in three random fields (each field covered more than 0.077 mm² in area, ×400), and a histogram of axonal diameters was constructed. The total number of myelinated fibers was calculated from the mean fiber density of the three fields and the entire cross-sectioned area.

Statistics
All data were presented as the mean ± SD. The Fisher’s PLSD test was used to evaluate the difference between the two groups, and a P value less than 0.05 was considered to indicate statistical significance.

RESULTS:
At 8 and 14 weeks, the nerve conduction velocity was significantly greater in the nerve lengthening group than in the nerve grafting group at each evaluation period (*p<0.05, **p<0.01, Fig 3). At 8 and 14 weeks, the total number of myelinated fibers was significantly greater in the nerve lengthening group than in the nerve grafting group (*p<0.05, Fig 4). Histologically, the mean axonal diameter was significantly greater in the nerve lengthening group than in the nerve grafting group at each evaluation period (Fig 5). At 8 and 14 weeks, the total number of myelinated fibers was significantly greater in the nerve lengthening group than in the nerve grafting group (*p<0.05, Fig 6). The histogram at 14 weeks also showed that there were more axons with larger diameters in the nerve lengthening group than in the nerve grafting group (Fig 7).

DISCUSSION: In the present study, the results of nerve regeneration after the repair of a nerve defect were significantly better in the nerve lengthening group than in the grafting group both electrophysiologically and histologically. To compare with nerve grafting, the repair after the nerve lengthening has a few important advantages. Firstly, only a single anastomosis site can increase the number of regenerating axons. Secondly, the lengthened nerve has vascularity and it will improve nerve regeneration. In particular, they may more favorable for a larger nerve defect. Thirdly, if this method is clinically applied, it doesn’t need to sacrifice the other healthy nerves. Lengthening of both stumps can be interactive and beneficial to nerve regeneration compared with lengthening of either one of the two. In conclusion, we believe that this technique should have a potential in the repair of segmental peripheral nerve defects.

REFERENCES: