Introduction: Although arthroscopic surgery developed in Japan has spread throughout the world and become the standard treatment in orthopedic surgery, there are many reports of serious nerve injury complications in elbow arthroscopy. In addition, elbow arthroscopy does not allow direct observation of the surgical field, and surgical operations are performed based on images projected on an arthroscope. We analyzed the motion of the surgeon using a motion tracking system to quantitatively evaluate the tacit knowledge of skilled surgeons and compare their techniques with those of young orthopedic surgeons.

Methods: Segmentation was performed from CT and MRI images of the elbow joint, and 3D data of bone, nerve, and skin were extracted to create a full-scale elbow joint model using an 3D printer. The free body was placed in the elbow joint model to simulate an intra-articular free body extraction, which is often performed in elbow arthroscopic surgery. Five skilled elbow arthroscopists and six novice elbow arthroscopists performed the simulated intra-articular free body removal procedure. Reflective markers were placed on the arthroscope and forceps, and the surgeon's movements were analyzed by wearing a bodysuit with markers and using a position tracking device.

Results: Skilled operators showed less wasteful movement of the arthroscope and forceps compared to novice operators, and the time to complete free body removal and the moving distance by the arthroscope and forceps were both shorter. The time required to complete the task was longer in the novice group, but the time for the procedure was reduced by performing the same task twice. The skilled operators also had significantly shorter moving distances for the head, shoulder, elbow, and wrist joints than the novice operators.

Discussion: There have been several reports in the field of microsurgery regarding the analysis of surgeon's movements.It has been reported that skilled operators have more stable forceps and needle holder movements, shorter moving distances of surgical instruments, and less blurring. When performing microsurgery, it is known that stabilization of the upper extremity, such as by placing the forearm and wrist joint on a table, allows the surgeon to handle the surgical instruments as intended.In our study, the surgeon's head, trunk, and upper extremity movements were stabilized. We speculate that in arthroscopic surgery as well as in microsurgery, the surgeon controls the movement of forceps and endoscope by non-consciously stabilizing the upper limbs.

Significance/Clinical Relevance: As a result of motion analysis of skilled and unskilled physicians, it was inferred that skilled surgeons stabilize forceps and arthroscope movements by non-consciously stabilizing head and upper limb movements. The novice surgeons improved their time to accomplish the task in the second session compared to the first session, and it is expected that repeating the elbow arthroscopy training system, which enables analysis of positional information, will enable quantitative evaluation and improve the technique.