

## Department of Orthopaedic Surgery

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### General Summary

#### *Basic Research*

Our studies of bone metabolism and osteogenesis have been highly acclaimed both in Japan and abroad. The research on bone metabolism has been focused on the relationship between osteoporosis and the risk of fracture. We have shown that high levels of pentosidine in urine or blood and mild hyperhomocysteinemia, which suggest bone collagen abnormalities, may be used as surrogate markers for evaluating bone quality and assessing the risk of fracture. Our clinical research focuses on the relationship between systemic disorders, such as lifestyle-related diseases and aging, and bone disease. In basic research, we analyze hard tissue characteristics in a mouse model of mucopolysaccharidosis, in collaboration with the Department of Pediatrics, and in epigenetically modified giant cell tumors, in collaboration with the Department of Laboratory Medicine.

Our studies of  $\beta$ -tricalcium phosphate ( $\beta$ -TCP) have played a pioneering role in the field of bone grafting. They have led to the wide application of  $\beta$ -TCP in many clinical settings; e.g., due to its efficient bone formation profile,  $\beta$ -TCP has been used as a complementary filling material in repair of bone defects.

#### *Clinical Research*

Our clinical practice has been divided into 10 subspecialties to treat a wide range of musculoskeletal disorders and is managed by different specialist teams: shoulder joint, spine, hip joint, knee joint, foot surgery, trauma, osteoporosis, rheumatic diseases, and sports. All teams maintain a high level of expertise and are actively involved in scientific activities.

The spine team has demonstrated the effectiveness of early open-door laminoplasty with hydroxyapatite block spacers and lamina plate. The lamina plate provides more rigid fixation than does hydroxyapatite block. The use of this novel lamina plate may help minimize complications and allow patients to engage in more aggressive rehabilitation programs. The technique might reduce both the incidence of postoperative axial neck symptoms and the loss of motion associated with traditional laminoplasty. The spine team surgeons have been investigating surgical outcomes of patients who had undergone laminoplasty with the developed technique.

The knee joint team has been performing total knee arthroplasties with patient-matched instrumentation and analyzed the effectiveness of cutting-edge technologies even more advanced than the surgical navigation system itself.

Through the wide range of clinical research activities, all teams fulfill their important

clinical, scientific, and educational roles at our academic hospital, and their commitment is highly valued.

### **Research Activities**

#### *Sport activities following nonoperative treatment of full-thickness rotator tears in elderly sports enthusiasts*

We performed a retrospective study of the results of nonoperative treatment in elderly sports enthusiasts who had full-thickness tears of the rotator cuff. The subjects were 35 patients (with 37 shoulders) with a mean age of 63 years. The size of the cuff tear was small in 8 patients, median in 19, global in 6, and massive in 4. The mean time of follow-up was 28 months.

The mean Japanese Orthopaedic Association score at the patient's first visit was 67 points. All patients quit their sports activities after the injury. At the final follow-up examination, the mean score had improved to 91 points and was correlated with the tear size. Although all patients returned to their previous sport activities, the Japan Shoulder Society Shoulder Sports Score had a mean value of 84 points and was also correlated with the tear size. Scores were low in patients with large or massive tears and patients who played tennis or swam.

#### *Clinical and research activities of the hand surgery team*

We treat many kinds of disease from trauma (fractures, tendon ruptures, and neurovascular injuries) to degenerative diseases and tumors. We also provide specialized surgical techniques for suturing tendons and microsurgery. Last year we performed more than 300 operations. After surgery, we cooperate with occupational therapists in the outpatient clinic to help patients achieve full functional recovery. Our clinical research focuses on collagen cross-linking in the hands of patients with Dupuytren contracture to clarify the etiology of this disease. Furthermore, we analyze risk factors of postoperative complications after enucleations of schwannomas.

#### *Open-door laminoplasty with novel plate spacers*

Laminoplasty is the most commonly performed surgical treatment for cervical compressive myelopathy. This conventional approach has complications, such as cervical axial pain and loss of neck range of motion. The open-door laminoplasty with only hydroxyapatite block spacers does not provide enough rigid fixation; however, with plates, more rigid fixation can be obtained. Using our newly designed plate for laminoplasty may help minimize complications and allow patients to engage in a more aggressive postoperative rehabilitation program. Our technique might decrease both the incidence of postoperative axial neck symptoms and the loss of motion currently associated with conventional laminoplasty.

#### *Femoral reconstruction with modular and interlocking stems in revision total hip arthroplasty*

We have adopted cementless reconstruction and used 2 stem-based reconstructions with a

modular system or with an interlocking stem. The objectives were to evaluate short-term results of femoral reconstructions with the adopted stems. A total of 120 revision total hip arthroplasties were examined. The complication rate was higher in the modular stem group, which had all 13 femoral fractures. The modular stem group also showed a higher rate of successful bone ingrowth (100%) than did the interlocking stem group (12%). Furthermore, femoral reconstruction was frequently complicated by fractures in the modular stem group; however, biological fixation was achieved, and good long-term results could be expected. The interlocking stem can be safely used with a low incidence of complications, and excellent short-term result can be expected. However, proper biological fixation is difficult to achieve.

*Computed tomography-based navigation-assisted total knee arthroplasty: Outlier analysis*

The purpose of this study was to analyze differences in the outliers' data between computed tomography (CT)-based navigation-assisted total knee arthroplasty and conventional technique arthroplasties. We retrospectively compared the alignment of 130 total knee arthroplasties performed with a navigation system with that of 67 arthroplasties done with a conventional system. The mean preoperative leg axis of 10 outliers in the navigation group was  $199^\circ \pm 3.1^\circ$  and that of 17 outliers in the conventional group was  $192^\circ \pm 9.7^\circ$ . The femoral component of the outlier cases in the navigation group was placed in the varus position.

We specified characteristics of the outliers and used postoperative radiographs to examine the accuracy of the CT-based navigation system. Our results suggest that the CT-based navigation system requires further improvements in accuracy.

*The mechanism by which systemic glucocorticoid administration causes weakening of the Achilles tendon*

Our study aimed to determine the mechanism by which systemic glucocorticoid administration causes weakening of the Achilles tendon. We used a mouse model to evaluate quantitative and qualitative changes in collagen. In the glucocorticoid group the maximum tensile load and the gene expressions of type 1 collagen and lysyl oxidase were decreased and the content of enzymatic collagen crosslinks was significantly lower. The corresponding amount of senescent crosslinks did not differ. The mean collagen fiber diameter was smaller. Our observations suggest that systemic glucocorticoid administration reduces the strength of the Achilles tendon by decreasing its collagen content, hindering formation of enzymatic crosslinks, and thereby causing collagen to remain in its immature state with smaller fiber diameters.

*Clinical and research activities of the bone metabolism team*

In our outpatient clinic specializing in bone metabolism, we provide individualized care with simultaneous estimation of bone quantity and quality. We treat several types of refractory bone disease, such as Paget disease, osteomalacia, and osteoporosis that is postmenopausal, induced by glucocorticoid, or associated with a hormonal disorder, childbirth, or vegetarianism.

Our clinical research is focused on the relationship of bone disease to systemic disorders, such as lifestyle-related diseases, and aging. Analyses of bone quality in patients with chronic obstructive pulmonary disease or nonalcoholic steatohepatitis are now in progress. In basic research, we analyze hard tissue characteristics in a mouse model of mucopolysaccharidosis, in collaboration with the Department of Pediatrics, and in epigenetically modified giant cell tumors, in collaboration with the Department of Laboratory Medicine.

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