

Department of Orthopaedic Surgery

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General Summary

Basic research

Recently, the basic research of the Department of Orthopaedic Surgery has focused on the functions of the main structural components of connective tissue, collagen, and proteoglycans, and studies to define clinically applicable biochemical markers is under way. We were the first research center in the world to suggest that collagen defects increase the risk of bone fractures; the idea provided the basis for research carried out by a Ministry of Health, Labour and Welfare study group and was incorporated into other large clinical trials. Furthermore, our concept that bone fractures are caused by abnormalities of the collagen structure was acclaimed by a Yale University professor in a *Nature*-related journal as an idea of great scientific importance which will inspire many research groups around the world.

In addition, successful results have been obtained from animal studies and human clinical trials in the field of reconstructive surgery, where the combination of growth factors and commercially available bone-grafting materials has been applied. Also in this field, some follow-up studies are being performed at other research centers, indicating that the road has been opened to the clinical application of the combined bone-grafting materials. Thus, the example of our department clearly indicates that relying only on research done by university graduates abroad plays a much less important role than does producing original study results, which can draw worldwide attention, lead to follow-up studies, establish world-acclaimed clinical standards, and thus define the "Jikei brand."

Clinical research

We believe that research at a cellular or experimental animal levels would lack meaning if it were not directly linked to clinical practice. As mentioned above, scientific concepts formulated at our department have already drawn worldwide attention and have led to follow-up studies and clinical trials.

Moreover, each study group within our department has developed metal plates or surgical devices intended to be directly applied to clinical practice. Furthermore, on the basis of the need to establish less-invasive arthroplasty methods and the rapid progress in this area, we have collected cases of computer-assisted arthroplasty. Submission of papers to international scientific journals is planned.

Research Activities

The learning curve of arthroscopic Bankart repair for anterior shoulder instability

The learning curve for arthroscopic Bankart repair procedure was analyzed for a single surgeon. The procedure was performed for 50 patients with anterior shoulder instability; 1 patient had a recurrent dislocation. The data obtained indicated that 20 to 30 operations are required for an inexperienced surgeon to gain the skills necessary for the arthroscopic Bankart repair procedure.

Results of nonoperative treatment of complete dislocation of the acromioclavicular joint

We evaluated the conservative treatment of complete dislocation of the acromioclavicular joint in 20 athletes, whose Japanese Orthopaedic Association ACS and Symptom Severity Scale scores at the final follow-up examination were 85.6/90 points and 89.7 points, respectively. Two patients underwent surgical treatment. Conservative treatment for grade III dislocations was more efficient for athletes, because of better clinical outcomes and earlier recovery to return to play.

Distal radius fractures

Recent reports indicate the effectiveness of planar-side locking plates in the treatment of distal radius fractures. To increase the effectiveness of this method, we filled the fracture void with β -tricalcium phosphate (TCP), a bone-grafting material developed in our department, and obtained successful results. This material is now being applied to the repair of the distal radioulnar joint.

A distinctive bone metabolism in patients with neurofibromatosis type 1

Loss of neurofibromin, a molecular defect found in patients with neurofibromatosis type 1 (NF1), affects the skeleton and is implicated in parathyroid hormone (PTH)-related anabolic processes. In our study, levels of bone metabolic makers and PTH in the sera of 34 patients with NF1 were examined. Levels of PTH exceeded the normal range in 20.6% of patients; therefore, we concluded that high PTH levels occur more frequently in patients with NF1 than in the general population. Hence, our results suggest that subclinical hyperparathyroidism plays an important role in the development of abnormal skeletal features in NF1, although the underlying mechanism is not understood.

Advantages of the modular femoral stem for primary total hip arthroplasty in patients with developmental dislocation of the hip

Rotational alignments of the sleeve and neck parts of the modular femoral stem were evaluated at primary total hip arthroplasty in patients with developmental dislocation of the hip. Proximal sleeves were implanted at various rotational alignment angles ranging from 20° retroversion to 76° anteversion due to proximal femoral torsional deformity. In 69% of patients, it was necessary to implant the neck part at a rotational alignment different from that of the sleeve part to obtain sufficient hip stability. The degree of adjustment of rotational alignment ranged from a 50° decrease to a 45° increase.

The results indicate significant advantages of the rotation-adjustable modular stem for primary total hip arthroplasty in patients with developmental dislocation of the hip.

Computer-assisted total knee arthroplasty

With the advancement of surgical navigation systems (computer-assisted surgery) and their application in total knee arthroplasty (TKA), various perioperative analyses have become available. In our department, computer-assisted TKAs are performed and local soft-tissue tension forces during patellofemoral joint repair are intraoperatively measured at different angles by using a computer-assisted surgery—specific tension balancer. Furthermore, a cutting device allowing custom cutting profiles based on 3-dimensional magnetic resonance imaging (MRI) data is being developed. A comparative study on joint alignment and efficacy of the device in future arthroplasty procedures is under way.

Development of osteotomy plates for hallux valgus

Hypermobility of the first ray is a predisposing factor for hallux valgus deformity. The results of our study suggest the first ray deviates dorsomedially during weight-bearing in patients with hallux valgus and that both the longitudinal and transverse arches become flat. To correct this deformity, 3-dimensional osteotomy of the first metatarsal is necessary. Because adequate fixing forces cannot be provided by conventional methods, specialized osteotomy locking plates are being developed. The configuration and size of the plates, the directions and number of screws, and osteotomy angles are being examined. Such plates would decrease the dependence on a surgeon's skill and, hence, improve operative results.

Granular cell tumor

The clinical course and pathologic features of granular cell tumor were studied. When MRI showed an unclear margin, histological examination usually demonstrated invasion of surrounding soft tissues. Thus, MRI is useful for preoperative planning; wide excision should be performed in locally aggressive cases.

Outcomes of bone giant cell tumor of the radius

All studied cases were classified as grade 3 according to the Campanacci classification. After aggressive curettage and adjuvant therapy with 99% ethanol, iliac bone grafting and plate fixation were performed. Recurrence was observed in 1 patient, in whom the same treatment was repeated without complications. The mean Enneking limb function evaluation score in all cases was 94%. The applied surgical method was useful as an initial treatment.

New approaches for assessing bone quality

The concept of bone quality is included in the Japanese Guidelines for Osteoporosis Prevention and Treatment. Evidence has accumulated that collagen cross-links play important roles in bone strength. We have demonstrated that in patients with osteoporotic fractures of the femoral neck, quantitative and qualitative deterioration of collagen cross-link formation might be affected by such factors as hyperhomocysteinemia,

oxidative stress, and vitamin B insufficiency. Additionally, we found that a functional polymorphism in the methylenetetrahydrofolate reductase gene locus, T allele (C677T), may be a risk factor for a future fracture. In a 5-year prospective study of Japanese women we found that a high urinary level of pentosidine is an independent risk factor for vertebral fractures.

Effects of alendronate on bone formation and osteoclastic resorption of beta-tricalcium phosphate

Resorption of beta-TCP is thought to involve both solution-mediated and cell-mediated disintegration. In our previous study, the mechanism of beta-TCP resorption was found to be based on cell-mediated disintegration by numerous tartrate-resistant acid phosphatase—positive giant cells. In the present study, 2 different experimental models were used, and the results showed that local application of alendronate reduced the number of osteoclasts on the surface of beta-TCP. Inhibition of osteoclast formation reduced beta-TCP resorption and, hence, enabled bone formation. Our results suggest that osteoclast-mediated resorption plays important roles in the resorption of beta-TCP and in bone formation.

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