

Preface

The wrist joint is engaged in virtually every human functional activity and as such, exposed to high number of traumatic injuries, primary osteoarthritis, and secondary degenerative disease. One of the most common skeletal diseases associated with the wrist joint is rheumatoid arthritis (RA). The disease affects mostly synovial joints, resulting in considerable pain, loss of function, and eventual deformity. It is a life-long condition, and the disease activity might change over time. As compared to the hip and knee joints, this disease was identified to easily affect the wrist joint.

There are three main symptoms of wrist with RA—cartilage destruction, synovial proliferation, and ligamentous laxity. Cartilage destruction caused by thinning occurs due to cytochemical effects resulting in degradation and inhibition of new cartilage. Additionally, bone erosion due to the synovial proliferation may cause sharp bony edges which might lead to tendon rupture. The laxity of the ligaments caused by the synovial expansion led to unphysiological bone translation and displacement. The pathological process of the RA starts with synovial inflammation primarily at the ulnar side of the wrist. It then spreads to the adjacent area including the radiocarpal joint, known as a critical region for the load transfer and joint motion. The adjacent cartilages, ligaments, and tendons degenerate accordingly. In severe cases, tendon rupture occurs with a consequence of kinematic changes of the wrist resulting in periarticular bones disruption at the articular surface. All the mentioned symptoms lead to the degeneration of both soft and hard tissues, and ultimately cause instability and mutilation of the joint.

For severe cases of RA, arthroplasty as an alternative to bone fusion treatment (arthrodesis) has an advantage in preserving the joint motion. It is, however, reported in numerous literature that this procedure is the most unsuccessful arthroplasty as compared to the knee and the hip arthroplasty. Two main causes were addressed, the implant loosening and metacarpal perforation. It is noteworthy to mention that to date, however, there are designs reported to obtain good clinical outcome for a short-term evaluation. Follow up procedures are still running assuring the reliability of the implant for long-term clinical application.

As one of established methods for prediction, finite element method was chosen to reaffirm those facts. Considering the inconsistent information on the reliability of the existing implant design, series of finite element analyses were performed to investigate the following aspects:

1. The biomechanical behaviours of the rheumatic wrist.
2. The biomechanical performance of the TWA procedure.

This monograph is devoted to emphasize and analyse these two main concerns in supporting better clinical treatment for patients with RA. The information is recommended for biomedical engineers and researchers interested in computational works, medical practitioners dealing with the determination of understanding the RA disease as well as its treatment, from both clinical and engineering perspectives.

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