Abstract of the Ph.D. Thesis

THE ARTHROPLASTICAL POSSIBILITIES OF ELBOW JOINT IN RHEUMATOID ARTHRITIS

by

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1. INTRODUCTION

The elbow joint has an important role in creating the functional harmony of the upper limb deriving from its central position. Its main task is to enable the arm and hand, together with the shoulder and the wrist, to fulfil their basic activity. From the point of view of power transmission this is one of the most important pillars. In spite of this it belongs to the most unpopular fields in orthopaedic surgery; the treatment is rather characterised by the persistent conservation, that by the orthopaedic activity based on carefully considered strategy. Some one of the reasons for this could be the complicated functional anatomy and biomechanical system of the joint, its significant susceptibility to contracture, and the indicational priority of operation in the lower limb, deriving from its polyarticular involvement, even though in case of a rheumatoid arthritis the elbow becomes 20-50 % affected. The breaking down of the balance between conservative and surgical treatment, the lack of financing the different arthroplastical alternatives by the Health Insurance and the loss of knowledge originating partly from this, brings about compulsion dissonances. Maybe this can explain that before this, in our special literature, no overall thesis has been written on the arthroplastical possibilities of rheumatoid arthritis. Because of the above-mentioned reasons two arthroplastical surgical methods have been introduced at the Orthopaedic Department of the ORFI (National Institute of Rheumatology and Physiotherapy) and the Orthopaedic Department of the Hajnal Imre University of Health Studies (now the Orthopaedic Department of Faculty of Health Studies, Semmelweis University). In 1987, for the first time in Hungary, an elbow prosthesis with a new-type fixing method was developed, which has been regularly used at the clinics since 1989. In possession of the experience gained from this prosthesis, or as one of its alternatives, a new surgical method has been worked out to use the dura mater interposition arthroplasty. The aim of this thesis is to get an overview about the arthroplastical possibilities of the elbow, to present the two methods we use, and to formulate those conclusions which can be applied in the orthopaedic treatment of rheumatoid elbow.
2. AIMS

Knowing the arthroplastical methods of the elbow and having overviewed its results, considering the gained experiences of the past years, I formulated the following aims in this thesis:

- To present the constructional and surgical technique of the elbow prosthesis with the new fixing method, and to formulate aspects of the indication and contraindication for surgery.

- To prepare the computerised, biomechanical model of the prosthesis, based on the structural parameters of the elbow prosthesis with the new fixing method, developed by us.

- To analyse the prosthesis from dynamical and statical points of view based on this biomechanical model.

- To draw conclusions from the results of the researches in order to clear up the presumable reasons of the loosening of the prosthesis.

- To evaluate the prosthesis from clinical and radiological point of view, to analyse the results statistically.

- To formulate the viewpoints of the surgical indications with the interposition arthroplasty using dura mater introduced by me, to describe the surgical technique.

- To survey of the patients operated with interposition arthorplasty using dura mater from clinical and radiological point of view, to analyse the results statistically.

- To formulate conclusions, with which the long-term applicability of the two methods in clinical surroundings can be justified, following a comparison of the prosthesis and interposition technique using dura mater.
3. HYPOTHESIS

- When developing the prosthesis, we expected it to be tissue-friendly, and at the same time firmly elastic, in order to absorb a great amount of the forces passing through the elbow joint with its reversible deformation, but to resist the shearing-torsion forces as a result of its firmness.

- No formation of abrasion waste material was supposed to be produced during the moving of the silicon components contacting each other, as a result of the friction-reducing effect of the synovial fluid in the joint and of the application of pure silicon.

- It was supposed that in spite of using a fixation without cement no early loosening in the patients mostly effected by rheumatoid arthritis would occur, because of the screw located near the moment centre of rotation of the elbow joint axis fixing the humeral component and because of the stiffening effect of the titanium plate in case of the ulnar component and the condesing effect of the adhesion of the triceps muscle.

- It was supposed that after implanting the prosthesis, the pain of the patients would significantly fall, and thus due to the increase of the movement range of the patient’s quality of life would improve.

- The interposition surgical technique using dura mater was formed as an alternate method for implantation of the prosthesis, to extend the possibilities of surgical indications. Using the ulnohumeral arthroplasty according to Kashiwagi well-known from literature, a new surgical technique was worked out not yet used in the literature, assuming that it was simple and could routinely be well applied.

- I also assumed that no pathological tissue reaction would be caused by the Tutoplast cadaver dura mater, it could be well-fixed during the operation, ceases or significantly decreases the pain of the patients, and would significantly increase the movement range, and no higher-degree bone-resorption proven by radiology would occur under the dura graft.
• I also supposed that the conclusions drawn from the implantation of the prosthesis, and from the homolog dura mater interposition, could lead to such conclusions which could prove the therapeutic effectivity of the process we introduced.

4. MATERIAL AND METHODS

An unconstrained, silicon, cementless elbow prosthesis has been produced together with the Inorganic Chemistry Department of the Technical University during the developmental work between 1987-1989. The humeral component is fixed by a transepicondylar compression screw. The ulnar component is fixed by the adhesion of the triceps muscle in the marrow cavity of the ulna and by the stabilising titanium plate of the component. After ceasing the difficulties of the computer-technical components been ceased, the dynamic model of the prosthesis was accomplished, using the geometry of the prosthesis and applying the three-dimensional computer-tomographic and the two dimensional slicing-plane images of the bones forming the joint. Throughout the dynamic analysis the rigidity parameters of the prosthesis were determined and the critical points of load were defined on the basis of the former one with statical analysis. The analysis proved the position of the maximal inner load in the surroundings of the screw passing through the humeral component. Pain, limitations of motion, the 3rd and initial 4th Mayo grade and the $< 10\degree$ instability were the indications for the surgery, while the deep infection, bony ankylosis, high-degree bone destruction and the high-degree instability meant the absolute contraindications. During the operation a posterior approach according to Van Gorder was applied in each case. No plaster bandage was used after the operation, and after some days the joint was mobilised with the help of the continuous passive motion principle. From 1989 to 1998 the implant of the prosthesis was used 33 times in 32 patients (one bilateral case), in 14 cases on the dominant side. The average age of the patients was 57.9 years (25-72 years). 85 percent of the patients were diagnosed with rheumatoid arthritis, 6 percent with juvenile chronic arthritis, 6 percent with post-traumatic osteoarthritis and 6 percent with osteoarthritis. 20 of the 32 patients were examined with a follow-up, 6 died and 6 did not appear. The average follow up period was 9.4 years (4-11.3 years). Clinical evaluation of the patients was carried out with the Mayo Performance Index (MPI), and during the radiological evaluation the radiolucent zone,
moving, dislocation and fracture of the components and fracture of the humerus or the ulna were considered.

As an alternative method to implantation of the prosthesis, the interposition arthroplasty using dura mater has been applied since 1997. The Tutoplast dura graft treated with osmotic solvent differs from the lyophilised graft, as its tensile and pulling strength is greater, since it preserves its collagen structure and its three-dimensional fibrin structure. From histological point of view a response reaction with identical tendency of the lyophilised graft, the settling and resettling of the graft may be detected without a tendency of rejection. The indication for surgery is nearly the same as that of the prosthesis, but it is completed with the fibrous ankylosis. A high-degree instability is not an excluding factor in case of the surgical contraindications. Otherwise the conditions are the same. The operation is carried out with the posterior approach according to Van Gorder. As a new, joint preserving surgical technique, applying the principle of the ulnohumeral arthroplasty according to Kashiwagi, the complete trochlea is wrapped with the dura graft. During the postoperative treatment the same process is used as the patients operated with prosthesis. The dura mater interposition was applied with 23 patients in 24 cases (one bilateral), from May 1997 up to July 2000, in 17 occasions on the dominant side. The average age of the patients was 52.2 years (24-75 years). The basic diagnosis was rheumatoid arthritis in 83.3 percent, juvenile chronic arthritis in 8.3 percent and post-traumatic osteoarthritis in 8.3 percent. All the patients appeared at the follow up examination and the average duration of the follow-up was 26.6 months (from 8 to 45 months). The clinical evaluation was based on the Mayo Performance Index, in line with the prosthesis cases. The radiological evaluation was carried out by comparing the rate of absorption, the height of the trochlea and the thinning of the olecranon, as was suggested by Ljung et al. Statistical calculations were completed with the help of the SPSS 7.5 program, with a paired student “t” test method and with the help of a statistical expert. The p<0.05 value meant the significance.

5. RESULTS

The 80 percent high-degree preoperative pain has decreased to 10 percent in case of patients with prosthesis, 20 percent of the patients had moderate, 40 percent had slight pains and in
case of 30 percent the pain disappeared. The difference of the average point values was significant (p<0.001). The average flexion-extension movement range has significantly increased (p<0.007). The decrease of the flexion contracture is not significant (p<0.116). The movement range of both supination and pronation increased, the change was significant in neither case (p<0.06 and p<0.462). Evaluating the stability of the preoperative patients, the state of 55 percent was stable and 45 percent belonged to the moderately stable group. In the follow-up examination 45 percent stable, 30 percent moderately instable, but 25 percent high-degree instability occurred. The increase of instability is not significant (p<0.095). Before the operation only

20 percent of the patients were able to furnish their vital functions, while in the follow-up examination 95 percent were able to do that, so their quality of life increased with 75 percent. Point values of MPI improved with 43.5 point on average, the difference is significant (p<0.001). The radiolucens zone wider than 2 mm justifying the loosening of the screw from radiological point of view, was formed in 30 percent. The moving of the humeral component occurred at an identical rate, together with the variation of the axis of the component, the average value of which was 10 degrees. In the surroundings of the ulnar component, a radiolucens zone wider than 2 mm was formed in 10 percent of the patients and moving of the component occurred in 35 percent of the cases. Comparing the loosening rate of the two components, a 40 percent loosening of the prosthesis could be proven. Reoperation had to be done in 33.3 percent of the patients. In 9 percent the screws had to be rewinded, in 9 percent the screw had to be replaced, and in 12.1 percent excision was done. Clinical signs of presence of synovitis induced by silicon was observed in none of the cases.

Following the interposition using dura mater, 50 percent of the patients reported no, 29.2 percent a very slight, and 21 percent a moderate pain. The difference is significant (p< 0.001). The average flexion and extension path of movement significantly increased (p<0.001). The average increase of the flexion contracture is not significant (p<0.128). A significant increase in the movement range

could be observed both in supination and pronation. Instability increased significantly (p< 0.026). The quality of life - as far as the basic vital functions are concerned - improved with 91.6 percent. The average value of the MPI increase was 53.2 points, and the difference is significant (p< 0.001). The absorption of the trochlea occurred in 8 cases (33.3 percent); in 5
occasions it was partial, and in 1 case in full degree. The rate of the partial absorption was 2.2 mm on average. Thinning of the olecranon happened in 12.5 percent, its average degree was 1.6 mm. Reoperation had to be done in 1 case (4.2 percent), when the radial head was resected.

6. CONCLUSIONS

1. When comparing the results of the prosthesis and the interposition technique using dura mater, the followings can be stated:
   a) In both cases a significant decrease of pain, a significant increase of flexion and extension, a significant improve of quality of life in the patients, and the significant increase of the Mayo Performance Index can be observed.
   b) After the interposition of dura mater instability significantly increased, although it was also determined by the high-degree instability of the patients before the operation.
2. The radiological loosening proportion of the prosthesis was about 25 percent higher during the follow up as it had been reported in the literature. The high short term loosening rate was not proven.
3. A change in the construction was suggested on the basis of biomechanical and radiological evaluation of the prosthesis.
4. The rate of partial absorption in the ulna and trochlea after the interposition of Tutoplast dura mater was smaller than the data given in the literature.
5. On the basis of the short-term clinical and radiological results the interposition using dura mater as an alternative way to the implant arthroplasty, may be applied with good results.