Abstract

"The design concepts of Kudo Total Elbow Prosthesis,and some of the technical considerations for its use "

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Total elbow prostheses which are now available in clinical use can generally be classified into two major categories ; one being linked prostheses, another being unlinked prostheses. Of those two categories I am dealing here only with the problems of the unlinked type prosthesis, particularly with those of non-constrained, surface-replacement prostheses. Furthermore, my presentations this time may have to be narrowed down only to the topics regarding the particular features and some of the technical problems with Kudo Elbow Prosthesis , due to the time limit assigned for this presentation.

Background of the current Type-5 Kudo Prosthesis

From 1972 to 1982, I had used a series of nonconstrained surface -replacement prosthesis (Type-1 and 2). The humeral component of both prostheses is made of stainless steel, and neither has an intramedullary stem. The ulnar component is made of ultra-high molecular weight polyethylene and has a short stem for intramedullary fixation. An interim report as well as a long-term follow-up study on the results of arthroplasty with use of these prostheses have been published. The main problem encountered with these prostheses was proximal subsidence of the humeral componet ,which was due in large part to the absence of the intramaedullary stem. To adress this problem , we developed the type-3 prosthesis, in 1980. The codylar portion of the humeral component of this prosthesis had almost the same shape as that of the Type-2 prosthesis, but an intramedullary stem was added. The Type-3 prosthsis was used with satisfactory clinical results, until 1987,and in 2001 its long-term results showing 90 % survival rate at 16 years post-op was published by Tanaka et al.

In 1988 , in an attept to develop an implant that could be inserted withou cement, the humeral momponent was modified to Type-4, which was made of titanium alloy with a porous-coated stem. However, the articulation of the titanium alloy against the high- density polyethylene led to tribological problems, such as metallosis and a high rate of polyethlene wear. This led us to modify the humeral componet to Type-5 in 1992 , which consisted of cobalt-chromium alloy with one half of the surfmace of the stem porous-coated with a plasmaspray of titanium alloy. Base of the stem was modified slightly to reinforce this area, in the hope of prventing breakage. The ulnar component was the same as that of the Type-4 prosthesis, except that an alternative ulnar component with metal backing and a porous coated stem was designed chiefly for use without cement.

Basic Design Concpt of the Prosthesis (Type-5)

1) No linking structure (an axis) between the two components is present.
2) The constraining mechanism at the articulating surfaces is kept minimal, but the shape at that site is so designed as to give an appropriate intrinsic stability to the articulation to prevent the instability or subluxation.
3) The amount of bone resection at the end of both the humerus and the ulna should be kept minimal (surface-replacement), and this guarantees the main portions of the components (for example; codyle molds of the humeral component) be strongly supported from underneath by the underlying bone stock.
4) Although the humeral component is made of cobalt-chromium alloy, the surface of a proximal half of the stem is porous-coated with the plasma-spray of titanium alloy, and as a result of this , high rate of success for cementless fixation can be expected even in osteoporotic rheumatoid elbows.
5) One of the unique features of this prosthesis is that the articulating surface of the humeral component has a shallow, wide monofacet configuration in the frontal plane, which allows for medio-lateral shifting of the ulnar component on the articular surface of the humeral component without the risk of lateral subluxation; thus the ulnar collateral ligament including the anterior oblique fiber can be released safely without any sequelae. Conversely, the rutine release of this ligamet is considered rather mandatory for carrying out this arthroplasty properly .

Some of the controversial issues over the surgical technique and its complications

1) Post-operative dislocation (posterior) is one of the big problems with the use of the unlinked type prosthesis. I felt one of the most contributing factors to this complication is the lack of soft tissue tension balance around the joint; particularly important in this regards being the failure to maintain an adequate tension in the fascial layer of the dorso-lateral aspect of the elbow (lateral to the olecranon) as a result of the inappropriate sutures for this structure when closing the joint. I personally believe the complete release of the medial collateral ligament including the anterior oblique fibers has nothing to do with this complication.
   Because Kudo elbow prosthesis, as stated above, allows for some degrees of medio-lateral shifting motion at the articulation of both components , there is no concern for the deleterious consequences to occur by total release of the medial ligamentum. In this regard I rather cosider that the dorso-lateral periarticular stractures of soft tissues including the lateral collateral ligament are far more important for prevention of the post-operative dislocation or instability.
2) Ulnar nerve neuropathy is the another nasty complicatin which may occur relatively frequently after the total elbow arthroplasty. In order to avoid this complication I have been

doing for the last 15 years the extensive ulnar nerve release at the first stage ,prior to entering the procedures of arthroplasty itself. In this first procedure I routinly release the ulnar nerve as far distally as possible beyond the cubital tunnel by splitting the muscle of the flexor carpi ulnaris and also by releasing the nerve from the deep flexor-pronator aponeurosis (Gabel,G T and Amadio, P C). The release of this thin aponeurosis must be done to the sufficently distal point until the nerve become completely free and mobile so that kinking of the nerve can be avoided while doing its anterior transposition at the last stage of the operation. In my experience there have been no case of post-operative ulnar neuropathy since the introduction of the above technique of handling the nerve.

3) Deep infection rate in our series of arthroplasty is ,so far, very low(less than 0.05%). During the operation we pay special attention for the periarticular soft tissues (particularly, the tendinous flap raised from the triceps tendons) not to get dried-up, and we rutinely lavage the wound with copious amount of the sailine solution at least four or five times, finishing the last lavage after immersion of the wound by locally instillating a proper amount of iodine solution(Popidone Iodine).
However, I am not certain about in what degree the above stated procedures have actually contributed to the lowering of our infection rate.

4) Loosening of the components is the most serious concern with any type of total elbow arthroplasty. Regarding Kudo Type-5 prosthesis (currently used) the longest follow-up is nine years, and as far as the humeral component is concerned there have not been any problems evident so far ; 100% success rate of osseointegration of the porous coated stem, and no osteolysis of condylar bone stock or no subsidence of the component being seen. Breakage at the base of the stem, which had been so often seen in the case of Type-4, has not occurred in any case of Type-5 prosthesis.
However, as far as the ulnar component is concerned, the most of which is made of all-poly ethylene and was fixed with acrylic cement, there has only one case of clinical loosening of this component out of 130 cases followed for 2 years or more. For this elbow, revision was done using a component of metal backed, long-stemed version.
Besides this case of the clinical loosening, there have been another 5 cases of radiographic loosening ; wide translucent zone at some portion of the bone-cement interface as well as slight transposition of the component being observed, but the clinical symptoms being almost nil in these 5 cases.
In view of this , we are now using even at the primary operation of some selected cases the modified version of the ulnar component with metal back and with a longer stem by 20 mm than that of the original one. I presently consider the indications for the use of this modified ulnar component are firstly the absence of sufficient bone stock in the trochlear notch of the ulna, particularly at the site of the coronoid process and secondly the presence of moderate or severe osteoporosis in the proximal end of the ulna.