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Treatment Options and Research Progress of Degenerative Elbow Osteoarthritis

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Abstract: *The incidence of degenerative elbow osteoarthritis increases year by year. Its main clinical symptoms are local pain and even stiffness, which are usually inconsistent with the radiological results(symptoms are often more serious). After failure of conservative treatment, it needs to be comprehensively evaluated the condition of patients, according to some factors: age, range of motion, pain, and the severity of osteoarthritis. It is more and more important for clinicians to choose specific surgical treatments, especially for young patients with elbow subluxation or instability. The current principles for treatment of this disease are: low level of pain, sufficient motion and good function.*

Keywords: *Osteoarthritis; Elbow Joint; Degeneration; Research Progress*

1. Introduction

Degenerative osteoarthritis of the elbow joint has historically been less prevalent compared to other joints. However, with the increasing occurrence of high-energy trauma in recent years, its incidence has shown a yearly upward trend. Etiological factors include not only overuse injuries and trauma, but also osteochondritis dissecans, osteochondromatosis, crystalline arthropathy, septic arthritis, and hemophilic arthropathy. Overuse or degenerative elbow osteoarthritis often involves cartilage damage or post-traumatic malreduction of fractures, resulting in articular surface incongruity or joint instability.

Although not a primary weight-bearing joint, the elbow joint - particularly the humeroulnar joint - routinely experiences compressive forces equivalent to 0.3 to 0.5 times body weight during daily activities, which can increase up to 3 times body weight during heavy manual labor [1,2]. Notably, this condition frequently demonstrates discordance between clinical symptoms and radiographic findings - severe radiographic changes may present with mild symptoms, while minimal radiographic abnormalities may be associated with significant clinical manifestations (Figure 1). Therefore, comprehensive diagnosis and injury assessment based on trauma history, clinical presentation, and imaging findings are crucial for developing individualized treatment plans. For this purpose, we will review and discuss various treatment options and current research based on factors including patient age, clinical manifestations, and severity of osteoarthritis.

2. Epidemiology

Limited clinical data exist on degenerative osteoarthritis of the elbow joint, and no statistical data are currently available regarding its incidence in the Chinese population. However, in a study by Guitton et al. involving 139 patients with elbow trauma followed for 10-34 years, 32 patients developed moderate-to-severe osteoarthritis (modified Broberg and Morrey functional score ≤60, see Table 1) [3,4]. The incidence of post-traumatic moderate-to-severe elbow osteoarthritis, in descending order, includes: distal humerus fracture-dislocations, olecranon fractures, radial head or neck fractures, and chronic injuries. Among these, in a study by Doornberg et al. of 30 patients with distal humerus fracture-dislocations treated with internal fixation, 22 developed mild-to-moderate elbow osteoarthritis and 2 developed severe osteoarthritis after 12-30 years [5]. In a study by Herbertsson et al. of 100 patients with radial head fractures (Mason type II or III) treated conservatively and followed for 18 years, all developed mild-to-moderate elbow osteoarthritis [6]. For surgically treated Mason type II or III fractures, Ikeda et al. found that the incidence of elbow osteoarthritis was less than 80%, attributing early osteoarthritis to improper internal fixation positioning, malunion after functional reduction, or partial osteonecrosis [7]. Among

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young patients with comminuted radial head fractures treated by radial head excision: Iftimie et al. reported a 100% incidence of elbow osteoarthritis, with 89% graded as moderate-to-severe [8]. Antuña et al. observed an 88% incidence of osteoarthritis, with 65% graded as mild and only 23% as moderate-to-severe [9]. Although these two studies differed in the reported incidence and severity grading of elbow osteoarthritis, most patients exhibited satisfactory postoperative elbow function with minimal pain symptoms. Notably, osteoarthritis grading was based entirely on radiographic findings, demonstrating inconsistency with clinical symptoms [8,9].

Table 1 The modified Broberg and Morrey scoring system

Function	Score
Range of Motion (maximum arc in each plane)	
Flexion (0.2 × arc of motion)	27
Pronation (0.1 × arc of motion)	6
Supination (0.1 × arc of motion)	7
Total	40
Strength	
Normal	20
Mild weakness (perceptible but not limiting, ≥80% of contralateral side)	13
Moderate weakness (some limitation in activity, ≥50% of contralateral side)	5
Severe weakness (limitation in daily activities, functional impairment)	0
Pain	
None	35
Mild	
Affects sports or strenuous activities (no analgesics required)	30
Affects daily activities (no analgesics required)	25
Moderate (occurs during/after activity, occasional analgesics needed)	15
Severe (present at rest, requires chronic analgesics, functional impairment)	0

In the study by Rochet et al., the incidence of postoperative osteoarthritis following olecranon fractures was 33%, with 6 out of 18 patients developing mild osteoarthritis during a 3-9 year follow-up period [10]. Papandrea et al. reported that among patients with malreduced elbow fracture-dislocations, 46-76% developed osteoarthritis. Their study suggested that persistent incomplete reduction may contribute to rapid progression of osteoarthritis [11].

3. Diagnosis

3.1 Clinical picture

Symptoms and Complaints: Age, occupation (heavy manual labor and competitive sports activities), pain intensity and duration (nocturnal pain suggests possible previous infection, persistent pain throughout the range of motion suggests severe osteoarthritis, end-range pain suggests possible osteophytes), range of motion and joint stability, treatment history (including surgical and non-surgical treatments such as local corticosteroid injections and topical applications), etc.

Signs: Measurement of elbow joint range of motion, joint stability testing, assessment for local skin abnormalities, condition of muscles and tendons (especially the triceps tendon and its attachments to the medial and lateral humeral epicondyles), and finally, ulnar nerve function examination (history of previous transposition surgery, presence of nerve compression, and sensory and motor function assessment).

3.2 Laboratory Tests

When infection is suspected or inflammatory signs are present, infectious disease markers should be assessed (including erythrocyte sedimentation rate, C-reactive protein, serum amyloid A, procalcitonin, etc.), along with cytological and pathogenic microorganism testing.

3.3 Imaging Studies

Includes X-ray examination and computed tomography (CT) examination to determine the severity of elbow osteoarthritis (whether there is osteophyte formation in the central or marginal areas, articular

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surface smoothness) and lesion location (whether the humeroulnar joint and/or humeroradial joint is involved), observe whether there are foreign bodies in the joint space, and assess whether there is elbow joint deformity. Among these, Larson and Morrey et al. classified the imaging findings into 4 grades based on the condition of the distal humerus (see Table 2 for details) [12].

Table 2: Larson and Morrey Radiographic Classification

Grade	Description
I	Intact distal humerus
II	Preservation of both medial and lateral columns
III	Absence of either medial or lateral column
IV	Complete absence of distal humerus

4. Treatment

Elbow joint dysfunction or loss of mobility caused by trauma and chronic injury is termed degenerative elbow osteoarthritis or elbow ankylosis. In recent years, the incidence of elbow osteoarthritis has increased annually due to factors such as traffic accidents and heavy manual labor. However, there remains considerable controversy regarding its treatment, with no consensus reached. The various treatment modalities for this condition are outlined below:

4.1 Non-surgical Treatment

For patients with localized pain, intra-articular corticosteroid injections or topical applications may be administered. In the study by van Brakel et al., after local corticosteroid treatment, 18 patients with elbow osteoarthritis experienced varying degrees of pain relief, with the longest relief period reaching 24 weeks [13].

4.2 Surgical treatment

Patients who fail conservative treatment should undergo surgical treatment. The specific surgical approach should be selected based on a comprehensive evaluation of multiple factors, including the location of elbow joint involvement (specific affected joints), severity (early or advanced stage, as clinical manifestations and imaging findings are often inconsistent in this disease, therefore the treatment plan cannot be determined solely based on imaging findings or Larson and Morrey radiographic classification, and severity assessment requires comprehensive evaluation combined with the modified Broberg and Morrey score), joint stability, and patient age, among others(see Figure 1 for the specific surgical treatment selection process).

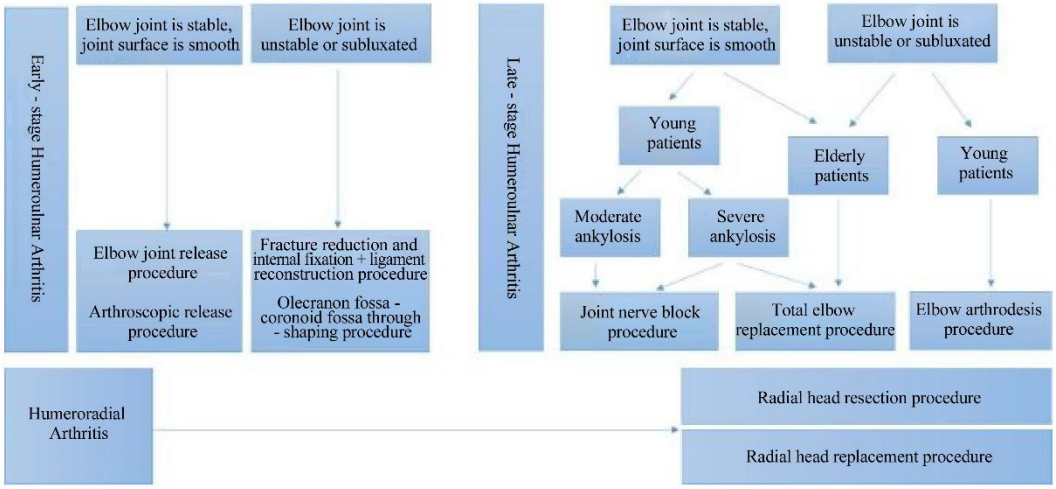

Figure 1: Surgical Treatment Algorithm for Elbow Osteoarthritis

Figure Note: Based on whether osteoarthritis involves the humeroradial joint and/or humeroulnar joint, it is classified as humeroradial osteoarthritis or humeroulnar osteoarthritis. Humeroulnar osteoarthritis is further divided into early and advanced stages based on disease severity. Additionally, elbow joint stability is categorized as stable or unstable/subluxated. The specific treatment plan is

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determined according to individual patient conditions.

It is worth noting that postoperative patient satisfaction depends more on pain relief than on improvement in range of motion. Patients' demand for pain relief is generally much greater than their need for improved mobility (the postoperative normal range of motion for the elbow joint is defined as extension −30°to flexion 130°[14]). Additionally, for younger patients with severe elbow osteoarthritis, the general principle is to delay joint replacement surgery as much as possible while ensuring good functional recovery and pain relief, preserving future surgical options, based on the patient's age and functional needs [15]. The specific surgical treatment options are as follows:

4.2.1 Humeral ulnar osteoarthritis

(1) Early humeral ulnar osteoarthritis, moderate to severe ankylosis of the elbow joint, good stability

Pain is usually the first symptom in these patients, and surgery is recommended for patients who cannot tolerate pain due to the presence of a foreign body in the joint or the formation of peripheral osteophytes, which usually occurs at the end of activity. There are two types of treatment: elbow release and arthroscopic release. In 1978, Kashiwagi proposed an elbow release surgery for the treatment of moderate to severe ankylosis of the elbow [16]. Specific surgical methods: take the posterior median approach of the elbow joint, after dissociating the ulnar nerve, make a median inclement of the triceps, open the posterior joint capsule, remove the olecranon osteophyte, remove the olecranon osteophyte if there is a foreign body, thoroughly clean the olecranon fossa, between the inner and outer columns of the distal humerus, bend the elbow after opening the window, enter the coronal joint, cut the anterior joint capsule and clean it (see Figure 2). Hertel et al. used this surgical method to treat 11 patients with degenerative elbow osteoarthritis, and after an average follow-up of 30 months, 75% of patients experienced pain relief and increased postoperative joint flexion range of motion from 66° to 100°. Osteoarthritis of the radial head was not reported in any of the patients [17].

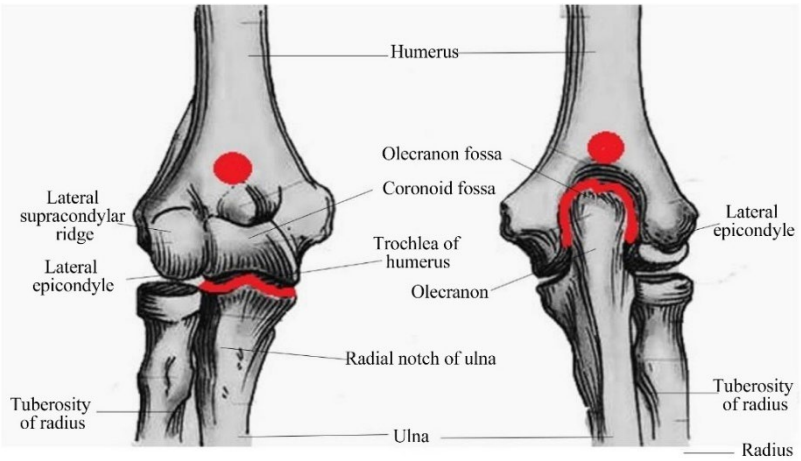

Figure 2: Schematic diagram of elbow release

Arthroscopic release, the specific surgical method is arthroscopic release of the anterior and posterior joint space, including the clearance of the olecranon fossa and coronoid process, such as foreign body removal and osteophyte removal. In the Phillips and Strasburger study, 15 patients with degenerative elbow osteoarthritis underwent arthroscopic release surgery, and after 18 months of follow-up, all patients experienced varying degrees of improvement in postoperative elbow function, with a flexion range increasing from 117° to 135° [18]. However, arthroscopic therapy is not recommended for patients with severe joint scarring due to poor microscopic vision and postoperative complications [19].

Cohen et al. compared open elbow release (n = 18) and arthroscopic release (n = 26) with greater pain relief in the arthroscopic surgery group and a more significant improvement in range of motion in the open surgery group at 12 months postoperative follow-up [20].

(2) Early elbow osteoarthritis with elbow subluxation or instability

Elbow subluxation or instability is positively associated with the development of elbow osteoarthritis. In the study of Mathew et al., persistent subluxation of the elbow joint was suggested, and uneven articular surfaces or cartilage damage were the main causes of elbow osteoarthritis [21]. In the study of Judet et al., it was suggested that the early stage of elbow osteoarthritis lesions was characterized by moderate articular cartilage damage, which necessitated fracture reduction and internal fixation +

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ligament reconstruction, especially of the lateral collateral ligament [22].

On the other hand, Jaydeep et al. [23] advocated olecranon fossa coronal fossa penetration, in which the olecranon fossa and coronal fossa are communicated by punching holes in the trochlea, so as to minimize bone destruction and keep the olecranon and coronal process unobstructed during elbow flexion and extension (see Figure 3). However, the long-term effects of such procedures are to be observed at follow-up.

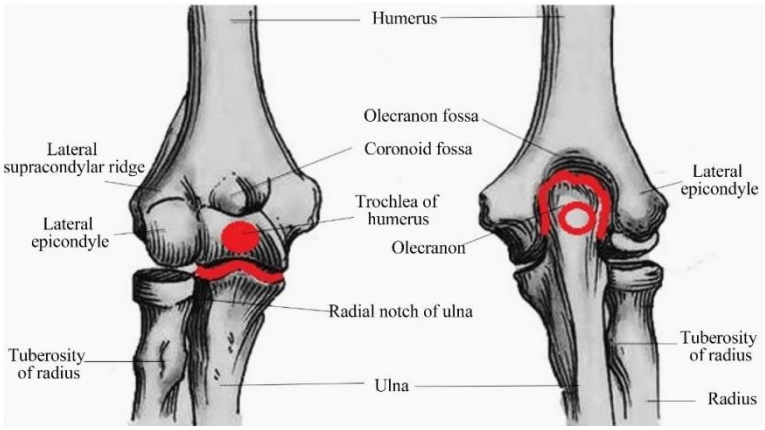

Figure 3: Schematic diagram of olecranon fossa coronal fossa penetration

(3) Advanced humeral ulnar osteoarthritis

Clinical findings in patients with this stage are often inconsistent with imaging findings, and some patients with severe elbow osteoarthritis are painless or fully tolerated. Depending on the patient's age, functional needs, and degree of joint stability, the following three surgical modalities may be used: joint nerve block, total elbow arthroplasty, and elbow fusion.

Elbow nerve block is recommended for patients with late-stage elbow osteoarthritis who are painful, have acceptable range of motion, and do not have indications for total elbow arthroplasty and elbow fusion, depending on the patient's age and/or functional needs. In the anatomical study of elbow innervation conducted by Winter et al., patients who underwent elbow nerve block had a greater than 70% reduction in pain intensity and were able to postpone joint replacement surgery [24].

Arthrodesis may also be performed in patients with degenerative elbow osteoarthritis who have severe pain and severe ankylosis, especially if there is a history of previous infection and a high risk of recurrence; young patients with high elbow stability and strength requirements; or severe bone, nerve and muscle defects in the elbow joint; or other elbow surgery failures require revision surgery. The main complications of this surgical procedure are nonfusion and secondary fractures.

Total elbow arthroplasty is the final surgical method (see Figure 4). Due to the longevity of the prosthesis, this procedure is only available for elderly patients and particularly young patients. Specific surgical method: choose the posterior approach or the lateral approach, free the ulnar nerve and anteriorly, and usually remove the radial head. For patients with intact ligaments and no deformity, ligament prostheses may be used. Semi-restrictive prostheses are generally indicated in patients with humeral condylar defects, joint deformities, and/or ligament injuries. Intraoperatively, the size of the joint space should be adjusted and determined based on the degree of joint release, flexion and extension of motion, and comparison with the contralateral elbow joint [25]. In the study of Mansat et al., 12 patients with degenerative elbow osteoarthritis (age range 33-68 years, average 54 years) were treated with total elbow arthroplasty, and after 2 years of follow-up, satisfactory results were obtained, and no significant loosening was observed. However, five of these cases required revision surgery, due to incision dehiscence, infection, etc. [26]. In the study of Schneeberger et al., 41 patients with degenerative elbow osteoarthritis treated with total elbow arthroplasty were treated with satisfactory results and no pain symptoms after at least 5 years of follow-up after surgery. Eleven patients developed postoperative complications, nine of whom required revision surgery [27].

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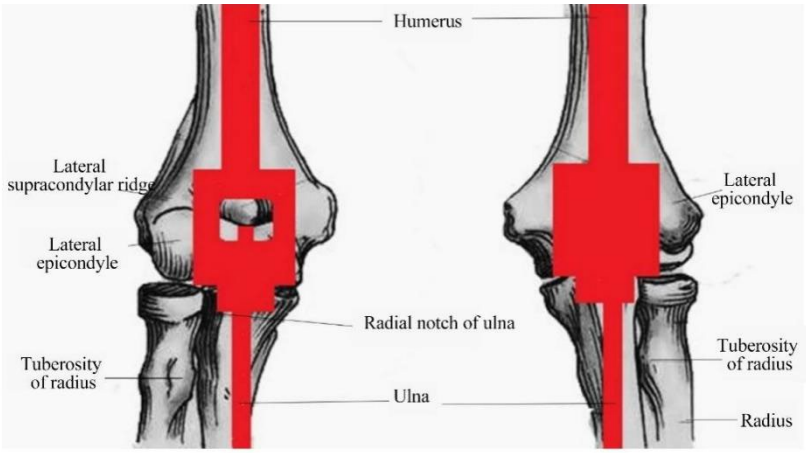

Figure 4: Schematic diagram of total elbow arthroplasty

In the Throckmorton et al. study, 84 patients with degenerative elbow osteoarthritis who were treated with semi-restrictive total elbow arthroplasty had complications after a mean follow-up of 9 years, and the vast majority were younger than 60 years of age. Throckmorton et al. identified infection as the main cause of early elbow replacement failure, while late replacement failure is due to loosening or fracture of the prosthesis [28]. In contrast, in a study of elbow replacement in 19 patients under 40 years of age with degenerative elbow osteoarthritis, 7 patients experienced postoperative complications and 5 patients required revision surgery [29].

4.2.2 Osteoarthritis of the humerus and radius

The occurrence of humeral and radial osteoarthritis is mainly caused by the malunion of radial head fractures, brachial and radial impingement, and Essex-Lopresti fractures. Surgery is recommended if lateral pain occurs during forearm rotation and imaging findings suggest osteoarthritis of the elbow joint. Commonly used surgical procedures are: radial head resection, elbow fork plasty, and radial head replacement.

In the study of Iftimie et al.,26 patients under 40 years of age with mild to moderate degenerative elbow osteoarthritis were treated with radial head resection, and after 25 years of follow-up, 21 patients were satisfied with the results without any pain symptoms (see Figure 5) [8]. However, radial head resection alone is not recommended for patients with preoperative elbow instability or subluxation because radial head resection increases stress in the humeral-ulnar joint cavity and increases the risk of postoperative elbow valgus. In addition, long-term follow-up may increase the risk of proximal radius displacement and ulnar variation of the wrist. Therefore, there is still some controversy about the simple removal of the radial head.

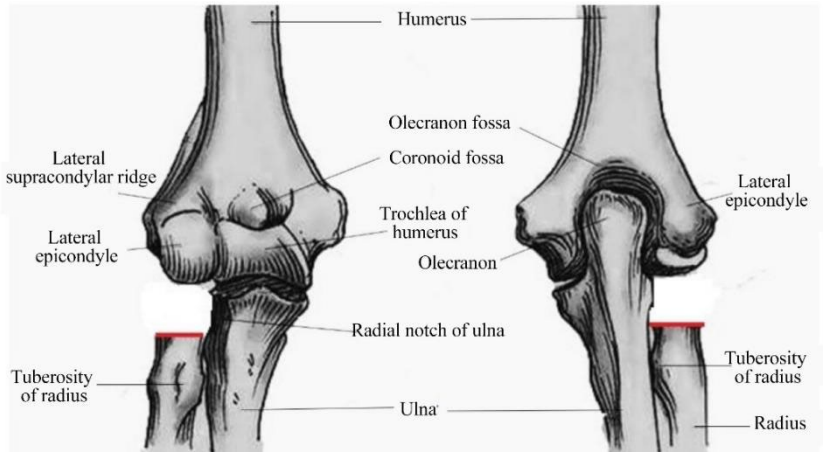

Figure 5: Schematic diagram of radial head resection

In the study of Shore et al., 32 patients with malunion of radial head fractures underwent radial head replacement, and 21 patients were satisfied with the postoperative results. However, after eight years of follow-up, 22 patients developed humeral-ulnar osteoarthritis, so it is considered that this surgical procedure is only suitable for patients with early brachioradial osteoarthritis and without significant

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humeral condyle injury (see Figure 6) [30].

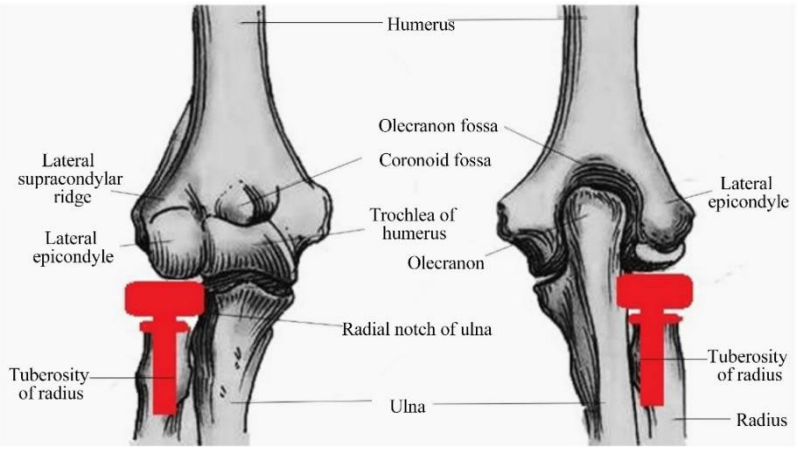

Figure 6: Schematic diagram of radial head replacement

5. Conclusion

In summary, degenerative elbow osteoarthritis has become one of the diseases that plague patients and clinicians (especially for young cases with high demand for joint stability and function) due to the increasing incidence of cases year by year, and a series of case-control studies and surgical methods have been discussed in the past. Although there is no unified treatment method and efficacy evaluation criteria, it is hoped that through the review and review of the literature, it is hoped that the diagnosis and treatment of this disease (especially moderate to severe elbow osteoarthritis with elbow ankylosis and elbow ankylosis will be helpful).

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