Pain and function in patients with rheumatic disease and elbow arthroplasty; clinical and methodological aspects

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Abstract

Pain and function in patients with rheumatic disease and elbow arthroplasty; clinical and methodological aspects

Background: About 20-50 % of patients with rheumatoid arthritis (RA) have elbow joint involvement, and total elbow arthroplasty is a treatment option if the joint destruction is severe. Loss of elbow function is considered to be more disabling than loss of shoulder or wrist function, since normal elbow function is required for positioning the hand. Outcome after total elbow surgery is often presented as range of motion (ROM). However, loss of elbow function may influence health related domains on impairment level as well as on activity and participation level. Thus, tests and instruments used for monitoring and evaluating the result of elbow arthroplasty ideally should reflect all these domains.

Objectives: The first aim was to describe the level of pain and physical function in patients with elbow arthroplasty. Secondly, a concurrent comparison of the methodological properties of four frequently used clinical- and patient assessed instruments for elbow function was performed.

Methods: As part of a routine postoperative follow-up examination 1-5 years after total elbow arthroplasty in patients operated at Diakonhjemmet Hospital, a protocol was developed for evaluating the properties of the Disabilities of Arm, Shoulder and Hand Questionnaire (Quick-DASH) (patient assessed), the American Shoulder and Elbow Surgeons Elbow assessment form (ASES) (combination of patient- and clinical assessed) and the Mayo Elbow Performance Score (MEPS) (clinical assessed). The patient assessed measure of upper extremity function (Quick-DASH) was considered as the "gold standard" for measuring elbow function. For comparison, all scales were transformed to 0-100, 100 best health. The single items of the Quick-DASH were examined for floor and ceiling effects (more than 15% lowest or highest score). Correlations between the different patient- and clinical assessed measures were examined by Pearson correlation coefficient (r), and the coefficient of determination was used to calculate shared variance between the different scores and the Quick-DASH. The Quick-DASH was used as dependent variable in a multiple regression analysis.

Results: Thirty-two patients, mean (min-max) age 68 (21-93), 75% female were included. The patients with elbow arthroplasty had low grip strength and a total arc of flexion/extension less than 100 °. They reported moderate level of pain (mean (SD) 77 (22)), while the mean (SD) upper arm function was 47 (20) for the Quick-DASH. Further, the mean (SD) satisfaction score was 69 (25), with 56% of the patients rating their elbow function as good or very good. Single items of the Quick-DASH regarding grip force activities showed floor effects. Significant correlations with Quick-DASH were found for all measures ($p<0.01$), except for ROM ($r= 0.2$, $p=0.35$). ROM explained 3% of the variance in the patient assessed function scores while grip strength explained 29%. In a multivariate regression model, grip strength contributed significantly ($p= 0.03$), while ROM did not contribute to the variation ($p=0.81$) in the Quick-DASH scores.

Conclusion: Patients with elbow arthroplasty reported moderate level of pain and they were (fairly) satisfied with the elbow arthroplasty. However, clinical tests revealed low grip strength and limited range of movement. Thus, both clinical- and patient assessed measures are needed for optimal evaluation and management of patients with total elbow arthroplasty.

Sammendrag

Smerte og funksjon hos pasienter med revmatisk sykdom og albuprotese; kliniske og metodiske aspekter

Bakgrunn: Omtrent 20-50 % av pasientene med revmatoid artritt (RA) har affeksjon av albuleddet. Total protese i albuen er et behandlingsalternativ når destruksjonen i leddet er av omfattende karakter. Tap av albufunksjon er antatt å være mer begrensende enn tap av funksjon i skulder eller håndledd, da funksjon i albuen er nødvendig for å kunne bruke hånden. Måling av leddbevegelighet (ROM) er metoden som i størst grad benyttes for å dokumentere resultatet av albuprotesekirurgi. Dette til tross for at tap av albuefunksjon påvirker kroppsstrukturer men også pasientens aktivitet og deltagelse. Kliniske tester og instrumenter som benyttes for å følge og evaluere resultater etter albu protesekirurgi bør derfor ideelt sett reflektere alle disse områdene.

Hensikt: Beskrive smerte og fysisk funksjon hos pasienter med albueprotese, samt gjøre en samtidig sammenlikning av de metodiske egenskapene hos fire mye benyttede klinisk- og pasientrapporterte instrumenter for albufunksjon.

Metode: Som del av en postoperativ rutinekontroll 1-5 år etter innsetting av albueprotese ved Diakonhjemmet sykehus, ble det utviklet en protokoll for å evaluere de metodiske egenskapene til the disabilities of Arm, Shoulder and Hand Questionnaire (Kvikk-DASH) (pasientrapportert), the American Shoulder and Elbow surgeons assessment form (ASES) (kombinasjon av pasientrapportering og kliniske evaluering) og The Mayo Elbow Performance Score (MEPS) (klinisk evaluering). I denne studien ble selv-evalueringsinstrumentet Kvikk-DASH antatt å være gullstandard for å måle funksjon i albuen. For å kunne sammenlikne, ble alle skalaer omregnet til 0-100, hvor 100 er best helse. Enkeltspørsmålene i Kvikk-DASH ble undersøkt for tak- og gulveffekter. Korrelasjon mellom de ulike klinisk- og pasientrapporterte instrumentene ble undersøkt ved bruk av Pearson korrelasjonskoeffisient (r), og koeffisienten ble benyttet for å regne ut overensstemmelse mellom de ulike instrumentene og Kvikk-DASH. Kvikk-DASH ble benyttet som en avhengig variabel i en multippel regresjonsanalyse.

Resultat: Trettito pasienter med gjennomsnittsalder (min-max) 68 (21-93) år, hvorav 75 % kvinner, ble inkludert. Pasientene viste lav gripestyrke og bevegeligheten i albuen (fleksjon/ekstensjon) var mindre enn 100 °. De rapporterte moderate smerter (mean (SD) 77 (22)), arm funksjonen var 47 (20) målt med Quick-DASH. Den gjennomsnittlige (mean (SD)) tilfredshetsskåren var 69 (25) og 56 % av pasientene vurderte albufunksjonen som god eller veldig god. Enkeltspørsmål i Kvikk-DASH som omhandlet gripestyrke viste gulveffekt. Korrelasjon mellom de ulike instrumentene og Kvikk-DASH var alle signifikante ($p<0.01$), unntatt for ROM ($r= 0.2$, $p=0.35$). ROM forklarte 3 % variasjon i den pasientrapporterte funksjonsskåren, gripestyrke forklarte 29 %. I en multippel regresjonsmodell hadde gripestyrke en signifikant betydning ($p= 0.03$), mens ROM ikke hadde betydning for variasjonen ($p= 0.64$) i Kvikk-DASH.

Konklusjon: Pasienter med protese i albuen rapporterte moderate smerter og de var relativt tilfredse med albueprotesen på tross av at kliniske tester viste lav gripestyrke og redusert bevegelighet. Både kliniske og pasientrapporterte instrumenter er derfor nødvendig for å oppnå en optimal evaluering og oppfølging av pasienter med protese i albueleddet.

Table of content

Acronyms and definitions

Activities of daily living	**ADL**
American shoulder and elbow surgeons	**ASES**
Canadian Occupational Performance Measure	**COPM**
Disease-modifying anti-rheumatic drugs	**DMARDs**
Health related quality of life	**HRQOL**
International classification of functioning	**ICF**
Mayo elbow performance score	**MEPS**
Medical Outcome 36-item Short Form Health Survey	**SF-36**
Non-steroidal anti-inflammatory drugs	**NSAIDs**
Occupational therapy/ occupational-therapist	**OT**
Osteoarthritis	**OA**
Patient rated elbow evaluation	**PREE**
Physical therapy / physio-therapist	**PT**
Range of motion	**ROM**
Patient reported outcome measures	**PROM**
Rheumatoid arthritis	**RA**
Short version, the Disability of Arm, Shoulder and Hand	**Quick-DASH**
Tissue necrotic factor blockers	**TNF**
Total elbow arthroplasty	**TEA**
Visual analogue scale	**VAS**
World Health Organization	**WHO**

Pain: "an unpleasant sensation and emotional experience with actual or potential tissue damage or described in terms of such damage" (The International Association for the Study of Pain, IASP, 1986)

Function: physical functioning and disability (body functions and structures, activities and participation) [77]

1. Introduction

Rheumatoid arthritis (RA) is a chronic, inflammatory systemic disease affecting the connective tissue, mainly in the musculoskeletal system, but also in extra-articular organs. Joint swelling, tenderness, pain, decreased function and stiffness accompany fatigue in the unpredictable deterioration of the disease, which in the long run may cause joint destruction [64]. RA has a prevalence of 0.5-1.0 % in the adult population in most western countries and is the most frequent inflammatory rheumatic disease [43]. Based on studies performed in western countries the prevalence of RA is higher in females compared to males [70].

Eventually, 20-50 % of the patients show clinical and radiological evidence of elbow joint involvement [4;32]. Elbow arthritis typically results in pain, stiffness and joint destruction. Elbow arthritis occurs most often in people with rheumatic diseases and, in some cases, with post-traumatic osteoarthritis after a traumatic incident, in most cases seen as a fracture of the supracondylus humeri. About 80 % of all elbow arthroplasties are operated secondary to RA or other rheumatic diseases [4].

The associated symptoms of chronic synovitis of the elbow, i.e. pain, deformity, muscle weakness, instability and loss of motion and may finally result in significant disability. The treatment is usually directed to reduce pain, next to reduction of inflammation and functional improvement. Non-surgical management consists of oral analgesics, intra-articular steroid injections, physical therapy and splinting [26]. However, when conservative treatment no longer provides relief, total elbow arthroplasty is considered as a treatment option in the prevention of permanent disability [51 30].

Total elbow arthroplasty can provide satisfactory results in patients with significant destruction of the elbow, especially in RA. With the introduction of the semi constrained prostheses, the complication rates reduced from 45 % in the late 1970s to 11-20 % in the 1990s [30 38 22 1]. However, severity of the disease in terms of joint destruction as well as several patient-related factors such as age, activity level and expectations should be taken into account before deciding upon this type of surgery. Due to issues regarding infection, loosening and prosthesis survival, this procedure is generally avoided in young active patients [63].

Individuals with a rheumatic disease suffer from a chronic, degenerative and systemic disease. In contrast to the single joint affection mostly seen in patients with osteoarthritis, the degenerative progression in RA patients most certainly will affect many joints over time, often resulting in severe impact on health related quality of life [37]. Because rheumatic diseases are often complex and affect many aspects of the patient's life, effective management requires the coordinated efforts of a diverse group of professionals. In addition to involvement in the contra lateral elbow, the adjacent shoulder and wrist joints are affected by the disease in up to 80 % and 90 % respectively [36]. Any treatment must account for disabilities of other affected joints and it is therefore important to develop a treatment strategy for the entire extremity [26].

To ensure the necessity of a total elbow arthroplasty, monitoring the disease course is important, in terms of assessing pain, strength, range of motion (ROM), physical function and daily activities over time. Studies providing results after elbow arthroplasty are mainly based on clinical assessed outcome measures on impairment level, most often presented as range of motion. Few have studied the elbow arthroplasty with standardized, valid and comprehensive instruments and methods (Table 2). For a long time, rating scales have often been used without formal testing of their measurement characteristics. Yet, in recent years increasing emphasis has been put on measurement theory in the evaluation of surgical orthopaedic treatments, and there is a broad consensus that outcome scales should be established and proven reliable and valid before they are used as an outcome measure [69 6 18 39 2]. Nevertheless, properly designed reliability and validity studies are still needed for the majority of commonly employed scores in orthopaedic surgery. There are multiple reports in the literature of the mid- and long-term results after elbow arthroplasty, but most of these are based on clinical assessed instruments; only few studies have employed standardized, valid instruments taking both the medical and the patient perspectives into account [4;34].

A surgical intervention, like total elbow arthroplasty, will probably influence patients' life in several areas. Ranging from impairment level, where the body-structures and -functions are measured to a more patient based perspective where the ability to perform various activities or participate in life situations are assessed. Over the last few years, the development of clinical outcome tools have shown that standardized, well tested instruments can give a valid and reliable reflection of the patient's health status and health related quality of life (HRQOL) in different health disorders and across different settings. This is particularly so

when taking the patient based perspective into account. In addition to assessing the direct impact of the disease on specific joint function, patient-based instruments allow the assessment of global functional capacity during the performance of everyday activities and of the patient's ability to participate in social activities.

1.1 Aims of the study

In a cross sectional follow-up examination 1-5 years after total elbow arthroplasty in patients operated at Diakonhjemmet Hospital, several frequently used methods and instruments for measuring elbow function were applied concurrently. The aims of this comprehensive examination was to describe the level of pain and function in patients with elbow arthroplasty, and to evaluate psychometric properties of some clinical- and patient assessed instruments for evaluation of elbow function after total elbow arthroplasty.

1.2 A priori hypothesis

1. Patients operated with elbow arthroplasty within the last 5 years experience moderate level of pain and have good function
2. The commonly used elbow instruments are appropriate for evaluating elbow function in patients with total elbow arthroplasty
3. The patient assessed instrument for evaluating total arm function, the Quick-DASH, can be considered as a gold standard for assessing elbow function
4. Clinical assessed outcome measures, such as range of motion and grip-force agree with the patient assessed function
5. The instruments can distinguish between patients reporting to have good elbow function and those who report to have moderate/ bad elbow function
6. Range of motion is frequently used for evaluating total elbow arthroplasty, thus satisfactory inter-rater reliability is expected

2. Background

2.1 The elbow joint

Three bones, the humerus, radius and ulna form the elbow joint. Articulations between the trochlea of the humerus with the ulna and the capitulum of the humerus with the head of the radius comprise the joint. The elbow is an example of a hinge joint, or a joint that moves in only one direction [63 75]. Two main movements are possible at the elbow. The hinge-like bending and straightening of the elbow (flexion and extension) take place? at the articulation between the humerus and the ulna. The complex action of turning the forearm over (pronation and supination) happens at the articulation between the radius and the ulna (this movement also occurs at the wrist joint). In the anatomical position (with the forearm supine), the radius and ulna lie parallel to each other. During pronation, the ulna remains fixed, and the radius rolls around it at both the wrist and the elbow joints. In the prone position, the radius and ulna appear crossed. Most of the force through the elbow joint is transferred between the humerus and the ulna. Very little force is transmitted between the humerus and the radius [75].

Normal passive elbow motion has been reported to range between 0 ° extension and 140 ° to 150 ° flexion. Greater variation of normal forearm rotation has been described, but averages about 75 ° pronation and 85 ° supination [49;52;54]. The functional ROM of the elbow has been shown to be 30 ° of extension to 130 ° of flexion and 50 ° of pronation to 50 ° of supination [52].

A functional elbow must have a total flexion-extension arc of 100 °. What is of particular importance, however, is the amount of motion used for daily activities and what each individual needs in their functional setting. To fulfill optimal function the elbow must be free from pain, mobile and stable [58].

Elbow function can be described as three activities: 1) to allow the hand to be positioned in space, 2) to provide the power to perform lifting activities and 3) to stabilize the upper extremity linkage for power and fine work activities. One may consider essential components of joint function as range of motion, strength, and stability. However, the final

determinant of function is ultimately determined by pain and the ability to perform activities of daily living [52].

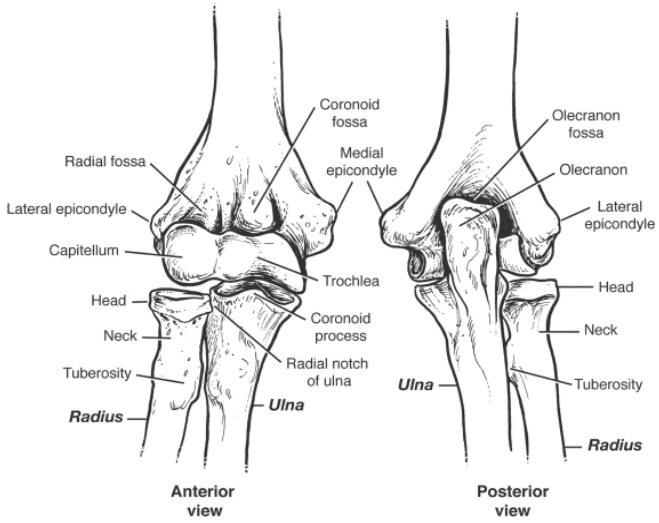

Figure 1: Bony anatomy of the elbow joint

2.2 Elbow Arthritis

Arthritis literally means joint inflammation and is not a single disease. Arthritis refers to a group of more than 100 rheumatic diseases and other conditions that can cause pain, stiffness and swelling in the joints. The three most common types of arthritis are RA, posttraumatic arthritis and primary osteoarthritis. The most common complaint associated with elbow arthritis is pain, along with reduced range of motion. Age and overall functional status of the patient are important factors to consider when formulating a treatment plan. In arthritis of the elbow, the cartilage of the joint is reduced or lost [63].

2.2.1 Prevalence of elbow arthritis

Unlike the hip, knee, and shoulder joints the elbow deteriorates as a result of primary osteoarthritis in only 1 to 2 % of the cases of elbow arthritis [26]. About 80 % of all elbow arthroplasties are operated secondary to RA [4]. The elbow joint is frequently involved in RA, eventually 20-50 % of the patients show clinical and radiological evidence of elbow joint involvement [18]. According to some scientific literature up to 50 % of patients with RA will present with elbow arthritis [63] [32]. There has been found evidence of 53 % elbow involvement

in a series of 300 patients with 10 years' average duration of RA [30]. In a 15 years follow-up of 148 elbows (74 patients with RA) the conclusion after 15 years was that more two of three patients with RA had elbow arthritis. This was mostly severe destructions and most often bilateral affection [46].

2.2.2 Rheumatoid Arthritis

Rheumatoid Arthritis (RA) is a common inflammatory joint disease that affects about 0.5-1 % of the population and up to 3 % of the population over the age of 65 years. It appears twice as often in women, and the age onset is mainly between 45 and 65 years. The clinical picture of RA is characterized by pain, fatigue, disability and reduced quality of life. The course of the disease is often unpredictable, and the symptoms may vary [64]. The disease is an immune-mediated process that affects the synovial and lines appendicular joints as well as the atlanto-axial joint of the cervical spine. It is associated with marked disability and decreased life expectancy. Patients can present with extra skeletal manifestations, such as anemia, pulmonary conditions, cardiac disease, and vasculitis. A thorough history and physical examination are essential when treating these patients. Patients with RA of the elbow usually complain of pain through the arc of motion [16]. The ulnotrochlear articulation is generally affected first although patients may display limitation in the forearm rotation as the disease process becomes advanced. Instability may also play a role in the elbow dysfunction. The loss of bony congruency, with or without destruction of soft tissue stabilizers, can often result in severe and symptomatic instability [63].

2.2.3 Posttraumatic Osteoarthritis

Posttraumatic Osteoarthritis may occur after any traumatic insult to the elbow, regardless of severity. It can occur in patients of either gender and of any age, but is most common in young males [51]. The risk of developing this condition correlates with both the injury pattern and the energy of the injury. Intra- articular distal humerus fractures, for example, are most often associated with the development of degenerative joint disease over time [58]. Similar to patients with RA, patients who suffer from posttraumatic osteoarthritis will complain of pain throughout the arc of elbow motion. In contrast, as a result of both articular incongruity as well as soft tissue contracture, instability is rarely a concern [63].

2.2.4 Primary Osteoarthritis

Primary Osteoarthritis (OA) of the elbow is a disease that is almost exclusive to males, and has a strong association with strenuous use of the arm in activities ranging from weight lifting to operating heavy machinery. It is a relatively rare disease, affecting <2 ° of the population [15]. In 1936, Rostock [63] reported a nearly 33 % incidence of primary OA in a large population of coal miners. Unlike OA of other joints, OA of the elbow is characterized by the relative preservation of articular cartilage and the maintenance of joint space, but with hypertrophic osteophyte formation and capsular contracture. The pattern of pain in patients with primary OA is quite different than that of patients with RA. OA patients classically complain of impingement pain at the extremes of motion, most notably in extension. During the early course of the disease, when the joint space is still maintained, osteophytes in the olecranon fossa and the proximal portion of the olecranon cause pain in the maximal extension. Similarly, if osteophytes formation occurs in the trochlea or in the coronoid process, impingement pain may be noted in extreme flexion. Patients may complain of pain throughout the arc of motion, but this is typically a late finding when the disease is more advanced [63 15].

2.2.5 Signs and symptoms of elbow arthritis

The complaints of patients who present with elbow arthritis will vary, depending on the specific arthritic condition from which they suffer. The clinical presentation of the patient with RA of the elbow depends on the stage of the disease. Complaints of pain and limited ROM, however, are common to all stages of the disease. It is well known that grip strength is profoundly affected in RA patients [9;10;68], and strength is directly influenced with pain, producing a reflex inhibition of strength [53]. Early on, synovitis is a prominent feature. Patients present with a warm, swollen elbow and painful limitation of the flexion- extension arc and the pronation-supination arc. A mild flexion contracture is to be expected. As the disease progress, the clinical features of synovitis become less prominent, and the painful limitations of elbow motion results from joint destruction and articular incongruity. The pain, now more mechanical in nature, occurs throughout the arc of motion. Loss of extension and resultant contracture develop rapidly [56]. With progressive bone loss and soft tissue compromise, up to 25 % of patients complain of instability [50 3].

2.3 Conservative treatment

Nonoperative management of elbow arthritis is similar to that of other arthritic joints. If not medically contra-indicated, patients should be prescribed analgesics, such as non-steroidal anti-inflammatory drugs (NSAIDs) for pain control. Many classes of drugs exist that can aid in the medical management of RA, including oral steroids, disease-modifying anti-rheumatic drugs (DMARDs), and tissue necrotic factor (TNF) blockers [76]. Intra-articular steroid injections can be very effective in the management of acute rheumatoid flares and have also been successful as maintenance therapy in patients with degenerative joint disease [63].

Elbow pain and stiffness can dramatically impair functional use of the upper extremity. Physical therapy is therefore important for optimizing general function in the adjacent joints and for the maintenance of mobility and strength. The maintenance of a functional arc of elbow motion (100 °) assures that the hand can be placed within a functional space for activities of daily living [58]. Heat- and cold therapy and gentle exercises may sometimes be useful for minimizing pain, but the evidence for such treatment is not clear.

Another important factor can be a joint protection program, which instructs the patient in techniques to perform activities of daily living with reduced joint reactive forces. This approach serves to reduce pain, minimize further joint deterioration, and conserve energy. Some of the basic techniques are to avoid aggravating activities, to respect pain and use it to guide physical activity, to avoid deforming positions, and to strike a balance between use of the elbow and rest. Hinged braces can serve to protect the elbow from stresses on the coronal plane while still permitting active range of motion. Night splints act to both rest, protect and to avoid contracture of the elbow during sleeping hours. For maximal benefit, most patients are advised to utilize all or some combination of these modalities and other assistive devices [58 56 63].

When non-operative modalities fail and surgical intervention is indicated, the type and severity of arthritis, as well as the age and activity level of the patient, will strongly influence the type of surgery best suited for the patient: open versus arthroscopic debridement, radial head excision, interpositional arthroplasty, total elbow arthroplasty (TEA), or arthrodeses [26 63 50].

2.4 Total elbow joint arthroplasty

2.4.1 Historical perspective

Elbow arthroplasty was developed in the middle of the 20th century, and for the first 20 years of its existence, it consisted largely of hemi-arthroplasty resurfacing of the humerus or ulna or both and were characterized by two relatively short stems with a highly constrained hinge that only permitted motion in the flexion/ extension plane. These implants were plagued by instability, loosening, and recurrent pain and overall poor function and the desire for varus/ valgus movement brought about the concept of hinge laxity. In 1972, Dee introduced the first cemented total elbow arthroplasty, which has had several modifications [66]. Many companies have followed since and they achieved good clinical outcomes with these replacements, but the rates of loosening were very high; up to 27 % after 3 years [71]. This disadvantage was probably caused by strong forces at the bone cement interface arising from the hinged articulation of the prosthesis. New developments were made, resulting in semi-constrained prostheses which more closely resemble normal elbow mechanics, reducing stress on the implant and the articulating surfaces. Finally, the non-constrained (resurfacing) types were developed, in which the humeral and ulnar components are not fixed together, but the collateral ligaments and annular ligament achieve the stability. For the last decade the semi- constrained and non-constrained types of the TEA have been, by far, mostly used [66 50 47 26].

2.4.2 The total elbow arthroplasty

There are many different prosthesis designs to choose between when performing a total elbow arthroplasty (TEA). The different designs are generally grouped as constrained, semi-constrained, and non-constrained. There is little consensus as to the best implant to use in different clinical settings [47 71].

Constrained implants confer coronal stability by limiting motion to flexion and extension, but they have fallen out of favour because these prostheses caused increase stress on the bone-cement interface and led to high rates of loosening. Non-constrained implants are the most anatomic and bone preserving. These systems, however, transmit more force through the adjacent soft tissues and therefore require inherent elbow stability, which is often lacking

in rheumatoid and posttraumatic end-stage arthritis elbows. The most common type of elbow replacement is semi-constrained prosthesis. Semi-constrained replacement allow 8 ° to 10 ° of varus/ valgus motion; this limited amount of constraint appears to offer adequate stability without overloading the bone-cement interface [26].

The Discovery Elbow System (Biomet Orthopaedics) is one of the latest generations of elbow replacement systems and is at the moment the system mostly used by orthopaedic surgeons at Diakonhjemmet hospital. It's minimally (semi-) constrained design provides more closely matching articular surfaces, avoids use of true hinge, and anatomically reproduces the axis of elbow motion. The Discovery Elbow System incorporates humeral and ulnar stems that closely match the anatomy of the medullary canals to correctly position and more anatomically reproduce hinge mechanics and axis of motion [33]. Important points of attention performed during the surgical procedure is decompression of the ulnar nerve for protection, the triceps is in most cases reflected off of the ulna and later repaired with sutures (pooley technique), the ulnar collateral ligaments is, if possible, preserved and the radial head is very often resected to avoid limitation in forearm rotation and continued pain, especially if the proximal radioulnar joint is arthritic (ibid).

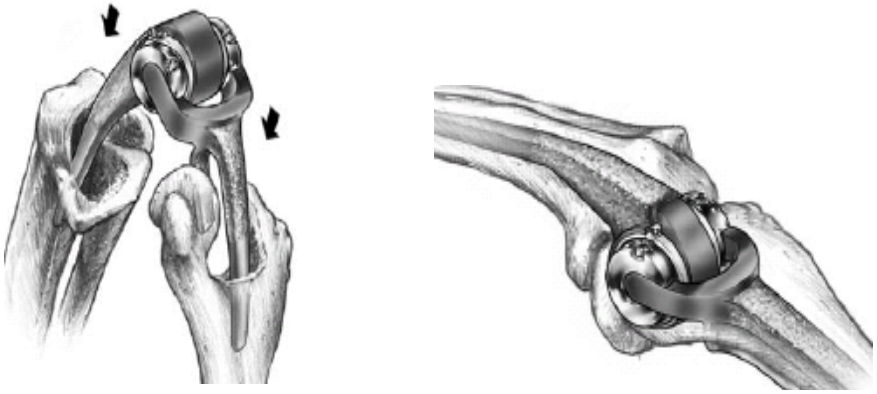

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Figure 2: The Discovery total elbow prosthesis

2.4.3 Indications and contraindications

Total elbow arthroplasty (TEA) is considered for those who have moderate to severe elbow arthritis that causes considerable pain, limitation of motion and functional deficit and who have failed nonsurgical treatment and the less invasive surgery. Due to concomitant disease

in the ipsilateral extremities, rheumatoid patients are expected to have decreased functional requirements and stress the implant less than others; therefore, any patient older than 30 years with gravely elbow arthritis and failed nonsurgical and less invasive surgical treatment might be a candidate for elbow replacement [26;32]. Although an unconstrained prosthesis can be considered for the stable rheumatoid elbow without notable bone erosion, semi-constrained, cemented implants are preferred in the majority of cases due to the high incidence of instability. Patients with primary osteoarthritis or posttraumatic arthritis of the elbow generally load the implant more vigorously and consequently can experience accelerated wear and loosening. The consensus minimum age is therefore advised to be 60 years (ibid). It is important to be aware of the patient's functional limitations and extent of polyarticular involvement before a total elbow surgery is performed. In cases of which the lower extremity is equally involved, consideration is given to reconstructing the lower extremity first in an attempt to avoid excessive stress being placed on the upper extremity implants through the use of aids [50]. Hand and wrist reconstruction is given precedence over TEA. In cases of equal involvement of the ipsilateral elbow and shoulder, the elbow generally takes preference over the shoulder. In one clinical study, greater functional return and a longer interval between replacements was observed when the elbow was operated on first [24]. The exception to this is when the shoulder is ankylosed. Then consideration is given to shoulder replacement first to reduce increased rotational stresses that might be placed on the elbow replacement as the result of absent shoulder motion. One study have found that when there is severe arthritis of both the shoulder and the elbow, consideration should be given to replacing both joints in order to obtain optimal functional and clinical outcomes [29].

Several contraindications exist and should be carefully considered to avoid complications [30]. First, active infection and, to a lesser extent, any previous infection of the elbow joint preclude insertion of a total elbow prosthesis. Second, skin marked by multiple scars or adherent to bone might not provide a suitable soft- tissue envelope to support an underlying implant. Third, poorly motivated patients or those with palsy of the flexor or extensor muscles might never attain enough function to make the extensive procedure worthwhile. Finally, patients are informed preoperatively that the elbow replacement will not hold up to excessive physical loads. Activity limitations are discussed and patients are advised on a lifetime limit to avoid lifting objects greater than 2.5 to 5 kg in order to prevent early implant failure [63]. Due to these activity restrictions, TEA is best performed in low-demand patients. Implant survivorship is better in low-demand patients functionally compromised by

rheumatic disease than in posttraumatic or osteoarthritis patients who otherwise are active and have no significant disabilities other than their elbows. Older age is described as a useful guideline for deciding upon employment of elbow replacement. In our current society, an increasing number of patients are maintaining physically active lifestyles, playing activities such as golf into their seventies and eighties. The decision to proceed with elbow replacement should be made considering both age and activity level [33].

2.4.4 Adverse effects of total elbow arthroplasty

There are numerous potential complications associated with total elbow arthroplasty. The most common is wound breakdown, and others include ulnar nerve irritation, deep infection, aseptic loosening, triceps deficiency, peri-prosthetic fracture, joint instability and implant failure. Wound complication after TEA may occur in up to 6 % of cases. The reported rate of deep infection of total elbow implants varies from 1 % to 13 % [38].

Aseptic loosening is a late complication of TEA and is usually separated into radiological loosening and clinical loosening. The rate of radiological loosening in an otherwise asymptomatic patient may be as high as 17 %, while the rate of clinical loosening is significantly lower (6 %) [63].

2.4.5 Rehabilitation after total elbow arthroplasty

Few of the studies regarding elbow arthroplasty discuss the use of physical therapy (PT) or occupational therapy (OT) after TEA explicit, and some papers even state that PT and OT is not required after total elbow arthroplasty [47;50]. However, postoperative follow up by physiotherapist and occupational therapist is common in the clinical practice. One important factor is communication between the surgeon and the therapist to assure appropriate follow up since there are several factors that will affect postoperative management. The main factors that affect rehabilitation include the type of implant used, the management of the triceps tendon, the overall stability assessed in the operating room and the status of the ulnar nerve. Patient goals and activity level also play a role in determining therapy guidelines and expectations after total elbow arthroplasty. Despite stringent guidelines for patient selection, there is still a variance in patient goals and expectations for range of motion, strength, and desired activity level following surgery. While all patients must be educated regarding the

limitations of the prosthesis, the patients with more active lifestyles often have to be reminded of these restrictions. They usually require slightly longer periods of protective splinting to prevent overuse. More active patients often tend to have increased expectations for range of motion and these patients tend to remain in therapy longer for passive stretching and static progressive splinting programs because of these increased expectations.

One of the major goals of TEA is to reduce pain and to restore motion of the joint. Once sufficient healing has occurred and the inflammatory phase of healing has passed gentle passive stretching can be performed. Further treatment is hands-on in terms of reducing edema and instruction in active exercise programs. Fabrication of splints is often done by the occupational therapist. Later on, once the elbow is comfortable and flexible, strengthening exercises and additional activities are started [66] [27].

3. Methodological theory

3.1 Outcome measures

3.1.1 The development of outcome measures

A health outcome measure has been described as a measure of health change, at a defined point in time, as a result of one or more health care processes [74]. The measurement of outcome has become increasingly widespread over the past two decades in response to move beyond more “appearance of benefit” as an indicator of therapeutic impact. The tools derived for this purpose are usually referred to as health outcome measures. The implementation, interpretation and evaluation of outcome measures have caused much debate and controversy over the years within the health literature. Historically, Florence Nightingale was one of the first to look critically at outcome. She concluded that regimental mortality in the Crimean war was inversely proportional to the distance from the hospital. From this she devised a system for comparing death rated by diagnostic category and went on to introduce the daily "outcome synopsis of: relived/ unrelieved/ died". This was in use until the 1960s. Another pioneer was E.A. Codman from the Massachusetts General Hospital. In 1910, he suggested a one-year recall on all patients treated to see if their treatment had achieved the initial objective. His classic paper on "the Product of a Hospital" (Codman, 1914) asked if this unclear question could be measured, perhaps in terms of: "healthy babies delivered, faithful nurses trained, promising young surgeons and physicians". He concluded with a question that is still central in clinical practice today- "what happens to the patient?" [23].

Two of the most dominant frameworks suggested for the measurement of health outcomes are; the International Classification of Functioning (ICF) and Health Related Quality of Life (HRQOL) [77].

The first conceptual framework, the ICF, formerly known as the International Classification of Impairment, Disability and Handicap (ICIDH), is a comprehensive conceptual framework of outcomes in the measurement of health [77]. The ICF assigns the term “functioning” as

encompassing the positive components of health, and “disability” as encompassing the negative components of health. Disability is further subdivided into impairments, activity limitations and participation restrictions within the context of environmental facilitators and barriers (ibid).

The second conceptual framework for the measurement of health outcomes is HRQOL. Although the precise definition of HRQOL is debated, there is agreement that HRQOL measures include multiple dimensions and that they are important to the individual and relevant to the particular health intervention [59]. HRQOL is purported to include dimensions that describe a persons physical, social and psychological health [59] [12;65]. Even if the definition is neither precise nor agreed, quality of life research seeks two kinds of information, the functional status of the individual and the patient's appraisal of health as it affects his or her quality of life [55].

In the last decades instruments for assessing function have had three main goals: to describe present function, to measure change over time and/or to predict function in the future. The different measures can be classified by the way they are constructed and developed in relation to what they measure. Outcome measures are often divided as either objective or subjective instruments. The objective instruments are developed based on the medical perspective, with focus on dividing sick from healthy and to grade deviation from what is believed to be a normal function. The assessment is performed by the use of medical technical equipment, e.g. goniometer to measure range of motion. The objective way to measure function have in common that it can be used for all patients, since it demands very little participation from the patient, except from following instructions [42].

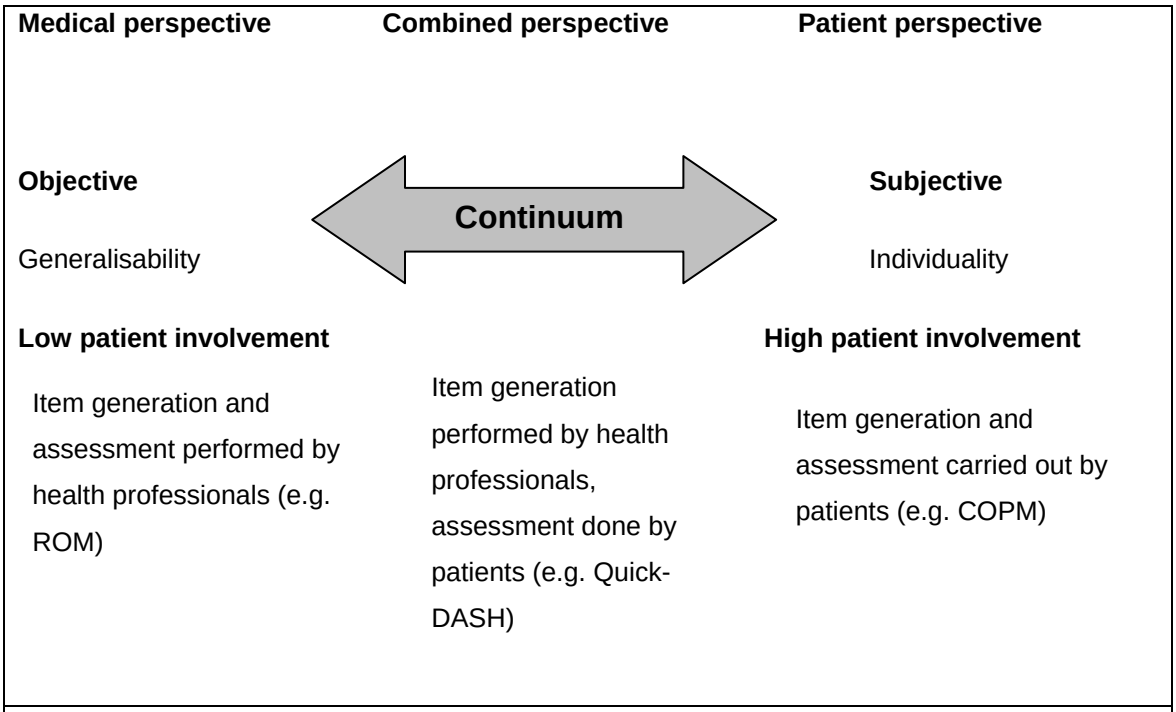


Figure 3: Measures of function, categorised according to construction and degree of patient involvement [42]

From the 1980's patients became to a larger extent involved in self-assessing their function. At the same time activity related perspectives became extended to also include work, social- and leisure activities [25]. Improved computer technology facilitated the opportunity to analyse huge datasets, and a number of questionnaires was developed and taken into account. One example is the Medical Outcome 36-item Short Form Health Survey (SF-36), which is a generic instrument used to assess function and HRQOL in a large group of patients [73]. Another example is the Disability of Arm, Shoulder and Hand (DASH/Quick-DASH) questionnaire which is a more site specific instrument, focusing on the functional status and symptoms of upper extremity as one functional unit [7;8].

Throughout the 1990's the patient perspective became more important. As a result of this, new dimensions of more patient perspective instruments were developed. In these instruments the patients were asked thorough interviews to describe and give preference to activities and goals, and then evaluate their own function and progression in relation to the priorities made [20]. One example of such an instrument is the Canadian Occupational Performance Measure (COPM) [13].

Over the past several years, the concepts of outcome research and assessment have become of increasing interest to clinicians, their patients and anyone who holds a stake in health care. A view of disease as a strictly biological phenomenon is no longer adequate; psychosocial consequences and functional impact are most relevant to patients and are key components in an assessment of the effect of disease or injury on health. The experience of health related challenges are often related to the patient's experience of the degree of pain, functional disabilities and quality of life (HRQOL). The complete assessment of the benefits of an intervention must therefore include evidence of the effect on the patient's health status and HRQOL. Such evidence is usually based on self administered or interview administered questionnaires, which are increasingly referred to as patient reported outcome measures (PROM) [23].

Two broad types of PROM exist; those that are specific to a site, disease or population and those that are generic and can be applied across populations, regardless of any underlying health problems [28]. By PROM it means questionnaires or related forms of assessment that patients complete by themselves or, when necessary, others on their behalf complete, in order that evidence is obtained of their experiences and concerns in relation to health status, health related quality of life (HRQOL) and the results of treatment [23]. Disease-, site- and population specific instruments have been developed in order to provide the patient's perception of a specific disease, health problem or in a certain population. The advantage is that the content is intended to be highly relevant, all of the items in the instrument should have been developed specifically to assess the particular population, site or health problem being studied [61].

3.1.2 Outcome measures and total elbow arthroplasty

Evaluation of total elbow arthroplasty requires outcome measurements that have the ability to clinically assess the direct impact on the specific joint function, but also patient assessments of global functional capacity during the performance of everyday activities and of the patient's ability to participate in social activities. Functional ability is considered as a clinical tool for measuring outcome, but one cannot only rely on measures on impairment level; the degree of degenerative changes on radiographs, or on generic measures of health status. Measurement of outcome after total elbow arthroplasty has tended to rely on non-standardized scales and mostly on isolated impairment measures. Range of motion (ROM) is

the measure most widely used, despite the fact that clinical assessed measures of elbow function do not necessarily reflect patient well being, performance in ADL and HRQOL, and vice versa [69].

The reporting of clinical outcomes after a total elbow arthroplasty has not fully evolved to routinely incorporate standardized outcome measures [48]. This is true for both objective- and clinical assessed measurements like strength and ROM and for more subjective- and patient assessed ratings of pain, activity limitations and social participation. Several clinicians and researcher have designed their own elbow rating scales, and there exist a number of different scoring systems and measures that are used and developed for evaluating the elbow joint, but a consensus on which information is most important and which is the most valid method in relation to elbow arthroplasty and rheumatic diseases has not fully been reached. Nevertheless, there have recently been reported some recommendations to which outcome measures preferable to include in a core set. The SF-36 is a patient-assessed generic HRQOL questionnaire assessing physical, mental and bio psychosocial health in a holistic manner [73]. The SF-36 has been used all over the world and has shown to have excellent psychometric properties and is responsive to change in patients with rheumatic diseases. SF-36 is proposed to be a part of a core set for assessing patients with total elbow arthroplasty [4 62]. The Patient-rated Elbow Evaluation (PREE) is also recommended, especially if a short set is preferable [48 62]. The PREE is a short patient-assessed questionnaire, four items assess pain intensity, one item assesses pain frequency and fifteen items assess disability. PREE is shown to correlate highly with the DASH [48]. Another recommended measure to include is the American Shoulder and Elbow Surgeons (ASES) [41], this instrument is included in this study and will be accounted for in chapter 4.2. The Mayo Elbow Performance Score (MEPS) [52] is a widely used outcome measure for this group of patients, but were excluded in the recommendations explained by the fact that all the items are covered by the DASH or the PREE (Angst et al. 73-82). One study also found that DASH and ASES perform a better assessment of pain and function than MEPS [69]. The MEPS and the Quick-DASH are explored in this study and will be explained further in chapter 4.2.

3.2 Psychometric properties of outcome measures

Psychometric properties are the elements that contribute to the statistical adequacy of an instrument, assuring that the instrument consistently measure the constructs that it was intended to measure. There are many different elements indicating whether or not instruments provide good psychometric properties, but the focus in this paper is on the validity, internal consistency and inter-rater reliability of the instruments explored [23] [19].

3.2.1 Validity

The validity of a measure is an assessment of the extent to which it measures what it is purported to measure. There are a number of different ways of establishing the validity of a measure. It is not a fixed property, but assessed in relation to a specific purpose or setting. It is therefore meaningless to refer to a validated measure; it should be considered a measure validated for use in relation to a specific purpose or set of purposes [23]. For example, a valid measure for assessing patients after a total elbow arthroplasty cannot automatically be considered valid for use for assessing patients after a total elbow arthroplasty. There are different types of validity. **Face** and **content validity** are related, but while face validity refers to what an item appears to measure based on its manifest content. Content validity refers to how well a measurement battery covers important parts of the health components to be measured. Together, they address whether items clearly address the intended subject matter and whether the range of aspects is adequately covered. **Construct validity** is a more quantitative form of assessing the validity of an instrument. Construct validity shows how well the instrument measures the theoretical construct that it was designed to measure [23] [19]. Construct validity is explored by examining relationships of construct to a set of other variables, expressed with correlations [60]. **Concurrent validity** is demonstrated where a test correlates well with a measure that has previously been validated. The two measures may be for the same construct, or for different, but presumably related, constructs. Concurrent validity is comparing a "new" tool or procedure with a gold standard. **Criterion validity** is used to demonstrate the accuracy of a measure or procedure by comparing it with another measure or procedure which has been demonstrated to be valid. **Known-group validity** determines whether or not the test or instrument has the capacity to distinguish between groups [23] [19]. The general concept behind known group validity testing is that a group of

individuals who are known to possess e.g., better function, score higher on a valid test than groups of individuals who are expected to have less function.

3.2.2 Reliability

Reliability is concerned with the reproducibility and internal consistency of a measuring instrument. If a measurement is free of random error, it is considered a reliable measurement with a true score of measure [23]. **Internal consistency** of an instrument is often measured by using Cronbach's alpha. All the individual items in an instrument should highly correlate with each other and with the summed score of the total of items in the same scale. All items need to be homogeneous, that is all measuring aspects of a single attribute rather than different constructs in order to have a good internal consistency. **Inter-rater reliability** is determined when two or more raters judge the performance of one group of subjects at the approximately same point in time [19 8;23]. If the score of the different raters is the same the test is believed to be of high or good inter-rater reliability. Description on how to perform and grade the test needs to be precise for a test to achieve a high or good inter-rater reliability (ibid).

4. Material and methods

4.1 Design, subjects and criteria for inclusion

This study has a non-experimental, cross sectional design. The patients were examined as part of a routine postoperative examination of patients with total elbow arthroplasty operated at Diakonhjemmet hospital during the last 5 years. A comprehensive examination was standardised by means of patient assessed instruments and a clinical examination. The clinical examination was performed subsequently by a surgeon and a physiotherapist, measuring strength, stability and range of motion of the elbow (Appendix I- IIII). (For convenience, a total of two surgeons and two physiotherapists were involved in the examinations).

32 patients met to the follow-up examination. They were all 18 years or older with uni- or bilateral primary or revision elbow arthroplasty. All patients met for follow-up at one point, independent of time since last surgery. Patients were excluded if they had a malignant disease, alcoholism, serious mental problems or cognitive impairment.

4.2 Instruments

The selection of instruments was based on those that were currently used in clinical practice or instruments that were described in the scientific literature to be either much dealt with or valid and clinically well tested for the upper extremity. The instruments explored in this study are the Disabilities of Arm, Shoulder and Hand Questionnaire, the short version Quick-DASH (Quick-DASH) [8 31], the Mayo Elbow Performance Score (MEPS) [52] and the American Shoulder and Elbow Surgeons (ASES) [41]. The methods consist of range of motion, pain, strength, stability, physical function, activities of daily living and impacts on social life. The measures contain patient- and/or clinical assessed instruments. The different conceptual frameworks of the measures explored, by means of ICF and HRQOL is illustrated in table 1.

The Quick-DASH is an 11- item score (short version of the DASH) that addresses disability of the upper extremity for all joints on both sides simultaneously. It has been validated and can be used for a variety of upper extremity conditions, but it tends to rate function more heavily than other measures used, as only two items ask about pain in the upper extremity [7;8;31;35]. Quick-DASH gives an overview of symptoms and function of both arms, but it has been reported that it can lead to problems in patients with multiple joints affected, e.g. patients with rheumatoid arthritis [21]. It has not been validated for patients with a total elbow arthroplasty (Appendix I). |

The MEPS have enjoyed widespread use (Table 2). It is primarily a clinical assessed instrument and contains assessment of pain, range of motion, stability and function on a total scale that rate 100 as the best score. 45 of the total 100 points are referred to pain in the elbow. MEPS contain clinical- and functional assessment completed by the clinician on the patient's behalf. Regrettably, there is a lack of standard terminology and information about how each item should be rated. The response items are not graduated, but just "present/ absent" options, and is therefore less able to discriminate between different grades of functional disability [52] (Appendix II).

The third outcome measure explored in this study is **the ASES**, which comprise of 2 parts, a patient- and a clinical assessed part. The patient assessed part consists of 5 items asking about pain on a 5 point categorical scale (5 equals worst possible pain) and 10 items concerning functional ability for both sides separately on a 4 point categorical scale ranging from 0 to 3, 3 equals not difficult to perform. One item concerns satisfaction with the arthroplasty on a 10 point categorical scale, ranging from 1 to 10, 10 equals very satisfied. The clinical assessed part consists of ROM, stability, strength, grip-strength and signs and symptoms. Weighting of the various subscales and the computations of a sum scale methodologically have not been reported for the ASES [48]. However, based on the concepts measured, the items were summarised in three subscales; function, pain and satisfaction. The different scales were analyzed separately. In other studies the ASES has been split into one clinical and one patient assessed part [4] and analyzed separately. **Grippit** were used to measure grip strength. Grippit measures both the maximum momentary force and the mean force over a set period of time (10 seconds). The instrument consists of a grip device, an electronic unit and an adaptor for connection to a power supply. The instrument is commonly used for patients with rheumatic diseases and has been tested for validity and

reliability for patients with RA [57 9 68]. Grippit has not been validated for patients with total elbow arthroplasty (Appendix III).

A Patient Global Assessment (PGA) of elbow function were also included, which is a one item question on a 5 point categorical scale ranging from 1 to 5 (5 equals bad function) (Appendix IIII).

For analytical purposes, the sum scores of the Quick-DASH, MEPS and ASES were all transformed, with 0 representing worst possible score and 100 representing best possible score.

Table 1: Measurement characteristics of the different outcome measures used in this study based on types of assessment and conceptual framework

	TYPE OF ASSESSMENT		**ICF**			**HRQOL**	
Outcome measure, instrument/test	Patient assessed	Clinical assessed	Body function and structures	Activity	Participation	Functional status	Subjective wellbeing
Quick-DASH	X		X	X	X	X	X
ASES func.	X	X	X	X		X	X
ASES pain	X		X	X		X	X
ASES sat.	X			X			X
MEPS		X	X	X		X	X
PGA	X			X		X	X
ROM		X	X			X	
Grippit		X	X			X	

Quick-DASH: Short version of the Disabilities of Arm, Shoulder and Hand function

ASES: American Shoulder and Elbow Score, function, pain and satisfaction

MEPS: Mayo Elbow Performance Score

PGA: patient global assessment

ROM: range of motion

5. Extended results

5.1 Characteristics of the study population

Total elbow arthroplasty is a surgical intervention often used as a last treatment option in the prevention of permanent disability for elbow joint destruction, mostly seen in RA. There are many studies in the scientific literature of the mid- and long-term results after elbow arthroplasty. However, most of these are based on clinical assessed outcome measures, only few studies have used standardized, valid and comprehensive assessments. Few studies have examined the comparability of the various instruments used, in relation to their relative psychometric properties. Table 2 shows the results of some comparable populations of studies that have employed the same outcome measures used in the present study.

The comparison shows that our population is somewhat older in mean age than the other populations presented in the table. The studies have about the same amount of participants (N), but some have more [4;44] and some have less [45] [34] patients included in their studies. The table illustrate that the different studies use different ways to measure outcome. Range of motion (ROM) is one of the measures most widely used. Figure 4 shows that our population has approximately the same mean ROM arc in flexion and extension compared to the other studies. Some studies report that their population had an arc over 100 ° [17] [4] while other studies including the present study [78] [40] have an arc below 100 ° (Fig. 4). When viewing other outcome measures our study has a lower mean score in the patient-assessed Quick-DASH compared to the similar DASH score [4]. On the other hand, our population reports less pain (ASES pain), but they are less satisfied (ASES satisfaction) with the surgery and do not experience as good function. When comparing the MEPS score, which is a clinical assessed sum score for pain and function, our population do not perform as well as the other studies in using MEPS as an outcome measure (Table 2).

Table 2: Studies viewing total elbow arthroplasty using some of the same outcome measure, the most relevant publications also used in figure 4 and 5 are presented in bold letters.

Authors, public. year	Design	N = participants (elbows)	Mean age (yrs)	Diagnosis, (beside from TEA)	Outcome measure (sum score mean, 100 best health, ROM flex.ext.)
Verstreken et al. 1998 [72]	Retrospective, follow-up 35.4 mnts	15 (16)	56	RA	MEPS: 89.3
de Boer et al 1999 [18]	Cross-sectional	42	60	RA, not all with TEA	MEPS: 78 ROM: 106 °
Yanni et al. 2000 [78]	Retrospective, follow-up 6.4 yrs	49		RA	MEPS: 88.4 ROM: 93.2 °
Tanaka et al. 2001 [67]	Pre/post- follow-up 16 yrs			RA	MEPS: 81/77
Lee et al 2005 [45]	Retrospective, follow up 39.4 months	7	55.5	RA	MEPS: 93.1 ROM: 101.3 °
Khatri et al. 2005 [40]	Pre/post, follow-up 82 months	47	57	RA	ROM: 88 °
Angst el al. 2005 (Angst et al. 73-82)	Retrospective, cross-sectional, follow-up 6-19 yrs (assessment of clinical outcome	79	64.1	RAPost-traumatic Osteoarthritis	SF-36: 57.4 DASH: 55.3 PREE: 66.8 ASES function: 75.6 ASES pain: 71.2 ,ASES satisfaction: 81 ROM: 107 °
Aldridge et al. 2006 [1]	Retrospective, follow-up 10-31 yrs	40	56	Degenerative elbow	MEPS: 91
Landor et al 2006 [44]	Pre/post- follow up 9.5 yrs.	58 (49)		RA	MEPS: 30/ 82
Hildebrand et al 2006 (Hildebrand et al. 1379-86)	Pre/post, follow-up 5 yrs.	16 (20)	64	RA, PtOa	MEPS: 78/90, Satisfaction: 86
Cesar et al. 2007 [14]	Retrospective, follow-up 74 months	34 (44)	55.7	RA	MEPS: 87.5
Torskog et al 2009	Retrospective, follow up	32	68.5	RA	Quick-DASH: 47.2, ASES pain:77, ASES sat: 69.4, ASES function: 52.3, MEPS 62.8, ROM: 97.6° , Grip-strength: 67.9 Newton

Quick-DASH: Short version of the Disabilities of Arm, Shoulder and Hand function

PREE: Patient-rated Elbow Evaluation

ASES: American Shoulder and Elbow Score, function, pain and satisfaction, pain, satisfaction, function

MEPS: Mayo Elbow Performance Score

ROM: range of motion

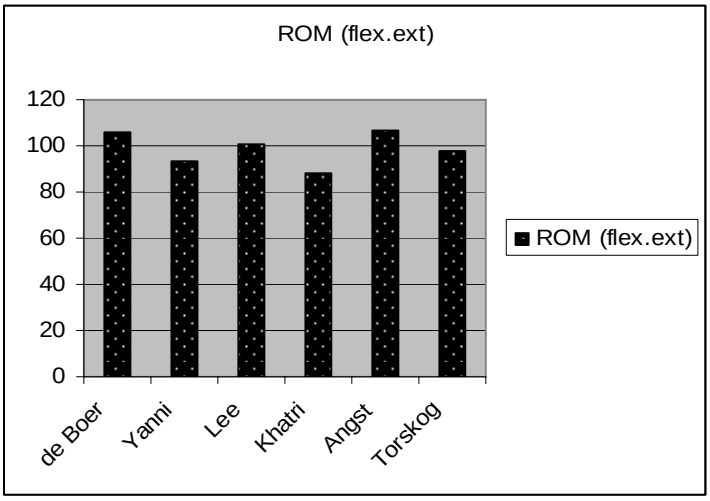


Figure 4: Comparison of ROM (flexion-extension arc) of the different populations in other studies dealing with total elbow arthroplasty presented in table 2.

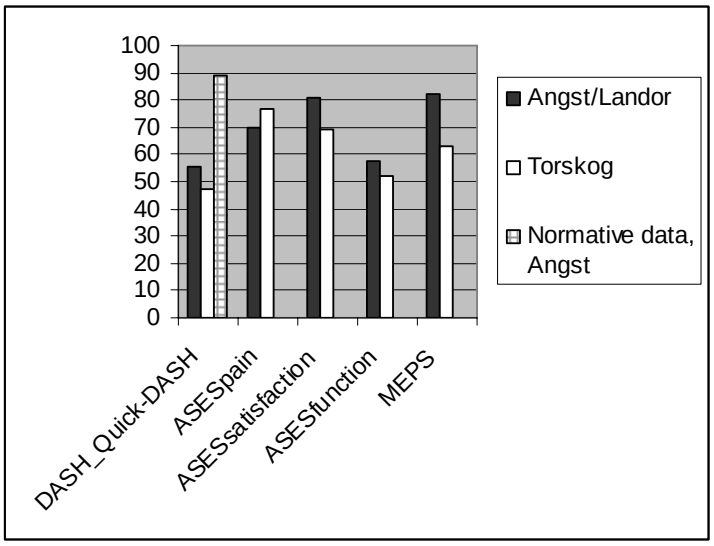


Figure 5: Comparison of the different outcome measures in other studies presented in table 2 using the same instruments when dealing with total elbow arthroplasty

5.2 Performance of the instruments

5.2.1 The content validity of the Quick-DASH

Based on the impact of the elbow joint for the total arm function, the Quick-DASH was considered as a gold standard among the instruments measuring elbow function in this study. It is therefore important not only to take the sum score of the Quick-DASH into account, but also how each item is assessed and distributed by the participants. Normal distributions are positive properties of a scale, and allow using sensitive parametric significance tests. Low ceiling and floor effects allow differentiating between the patients by the score [5]. When scores "top out" and the item or instrument cannot register greater gains, this term is called ceiling effect, when scores "bottom out" and the item or instrument cannot register greater declines, this is termed floor effect [19].

The sum score of the quick-DASH was normally distributed (Fig. 6), but some of items disclose what the participants experience as most or least difficult, also expressed as floor or ceiling effects. Grip force activities (open jar and recreational activities) showed floor effect (more than 15% of the participants reported worst possible score [60]), whereas the "social participation/involvement" item showed ceiling effect (Fig. 7).

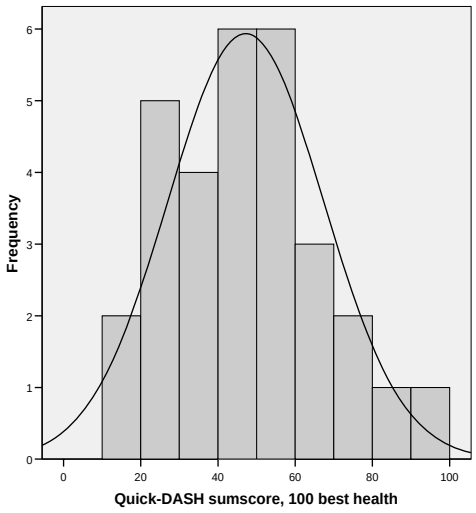


Figure 6: Histogram of the sum score of Quick-DASH for this population (n=30), mean (SD) 47.2 (20.2)

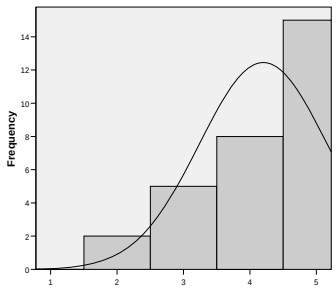
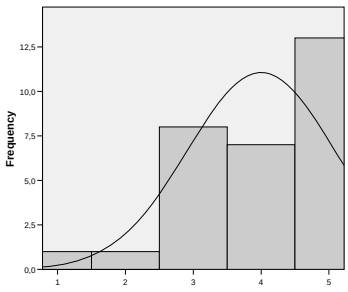
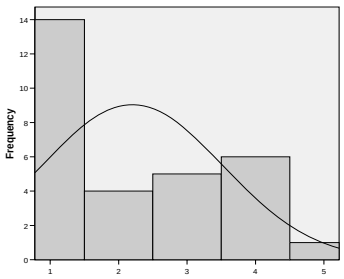
Ceiling effects/ difficult activities		Floor effect/not difficult activities
Open tight/ new jar, ceiling effect, mean (SD) 4.2 (1) 46.9 %	**Recreational activities with use of arm/shoulder/ hand**, ceiling effect, mean (SD) 4 (1.1) 40.6%	**Interference of arm/ shoulder/ hand with normal social activities**? floor effect, mean (SD) 2.2 (1.1) 43.8 %
		

Figure 7: Single item presentation of the floor and ceiling effects of the Quick-DASH (1-5, 5 worst possible score) n= 30

5.2.2 Discrimintive ability of the outcome measures

In order to evaluate the instruments ability to discriminate between patients who report to have good function compared with those reporting moderate/ bad function, the total group of participants was split into two groups based on their own reported assessment of the elbow function after the total elbow arthroplasty.

The group was dichotomized to good function (very good, good) and moderate/bad function (middle, bad, and very bad). The mean score of the different variables were compared using the Students independent-samples t-test [60].

The ASES function ASES pain scores showed a statistically significant difference between The group that reported good function and those who reported moderate/bad function ($p<0.05$). Grip strength did not discriminate between the groups, showing low grip strength for nearly all patients. ROM between the two groups show a statistical relevant difference between the groups ($p= .011$), those who report good function have an arc over 100 ° while those who report moderate/bad function have an arc below 100 °. Having a flexion-extension arc of more than 100 ° have previously in the paper been described as what is needed to have

a functional elbow. This might indicate that patients who report to have a functional elbow of more than 100 ° report to have a good functioning total elbow arthroplasty.

Table 3: Students independent samples t-test, comparing those who report good function with those who report moderate/bad function

Instruments/ tools	**Good function** Mean (SD)	**Moderate/bad function** Mean (SD)	p-value	SMD[1]
Quick-DASH	53 (21.7)	40 (15.9)	.082	0.69
(0-100, 100 best)	N= 17	N= 13		
MEPS	68.1 (21.5)	55.8 (15.2)	.092	0.67
(0-100, 100 best)	N= 17	N= 13		
ASES function	62 (29.2)	40.5 (26.8)	.043	0.77
(0-100, 100 best)	N= 17)	N= 14		
ASES pain	88.4 (16.7)	61.1 (17.3)	.000	0.04
(0-100, 100 best)	N= 18	N= 13		
Grippit (Newton)	54 N (31.1)	57 N (72.6)	.876	0.06
	N= 16	N= 12		
ROM (degrees °)	105 ° (9.7))	87 ° (26))	.011	1.008
	N= 18	N= 14		

[1] Standardized Mean Difference, effect size for group difference

Quick-DASH: Short version of the Disabilities of Arm, Shoulder and Hand function

ASES: American Shoulder and Elbow Score, function, pain and satisfaction, pain, satisfaction, function

MEPS: Mayo Elbow Performance Score

ROM: range of motion

5.2.3 Inter-tester reliability

Inter-rater reliability is considered good if the scores of the different raters are equal when performing the same test at the same time. It is important both in clinical practice and in research that the test is reliable when performed by different raters. An important factor is therefore that the description on how to perform the test and how to score the assessment is precise [19]. It is also of importance that the clinicians are trained on how to perform the different tests and that the patients are given a clear and standardized explanation on how to perform or assess the questionnaires (ibid).

Range of motion is, as described earlier, one of the clinical tests mostly used in evaluation of total elbow arthroplasty. In this study, a surgeon and a physiotherapist measured the range of motion of the elbow subsequently.

The results of the inter-rater tests were visualised by Bland Altman plots. The Bland Altman method is a statistical method to compare two measurement techniques or raters. The graphical method displays the differences between two raters plotted against the averages of their scores [11].

In Fig. 8, the agreement between the surgeon and the physiotherapist was examined graphically by plotting the differences between the two raters (y-axis) against the mean of their scores (x-axis). The limits of agreement were calculated as the mean difference between the raters ± 1.96 SD of the difference.

The smallest detectable difference (SDD) was calculated as the mean difference multiplied with 1.96 SD of the mean score, and reflects the inaccuracy of the goniometric measuring method in this patient group. The margin of error was nearly 30 º for flexion, for extension 12 º and for pronation / supination arc as much as 57 º. This means that when estimating change in elbow flexion for example, the result must exceed 30 º to be regarded as a real change (more than the error of the method).

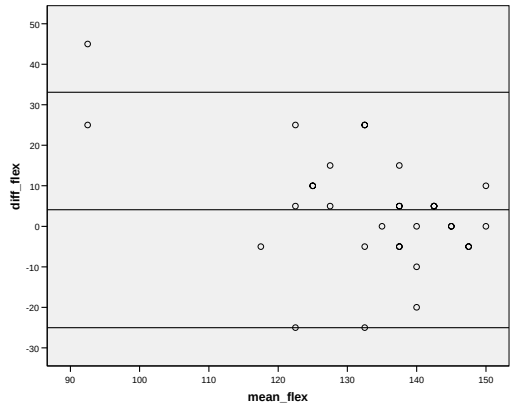
Table 4: Inter-tester reliability: range of motion (ROM) measurements of the elbow between to testers (surgeon and physiotherapist)

ROM elbow	Surgeon mean ° (SD)	Physiotherapist mean ° (SD)	LOA[1]	SDD[2]
flexion	135.2 (12)	131.1 (18.5)	33.1, -24.95	**29**
extension	-34.4 (16.7)	-35 (15.8)	12.4, -13	**12.4**
flex/ext arc	98.6 (20.5)	95.6 (21.1)	12.3, -18.3	**15.3**
pronation	60.9 (28.1)	68.8 (29.5)	50.5, -34.9	**42.7**
supination	64.1 (30.5)	58.7 (28.4)	30, -40.6	**35**
pro/sup arc	124.7 (49.4)	127.5 (52.1)	59.8, -54.2	**57**

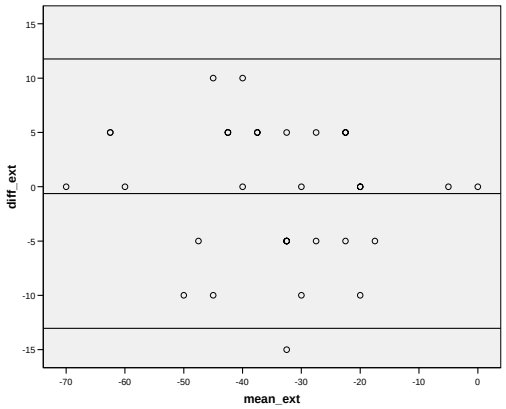
[1]Limits of agreement (mean difference between the raters ± 1.96 SD of the difference)

[2]Smallest Detectable Difference (mean difference between testers) x (1.96 x SD mean diff)

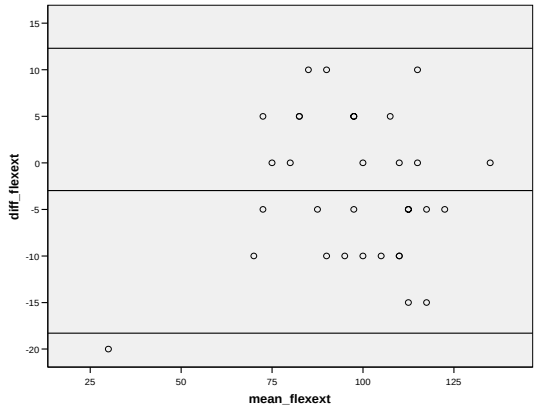
Flexion



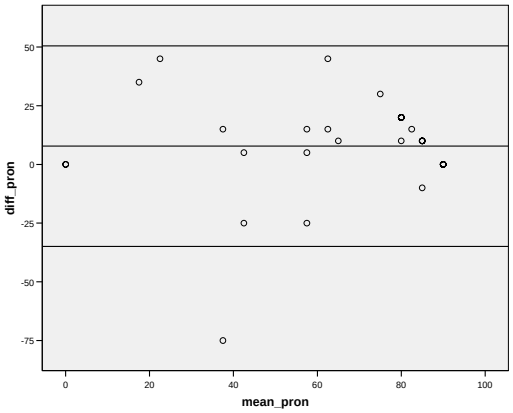
Extension



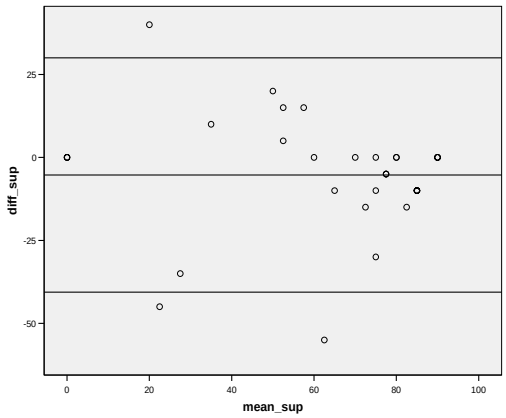
Flexion- extension arc



Pronation



Supination



Pronation- supination arc

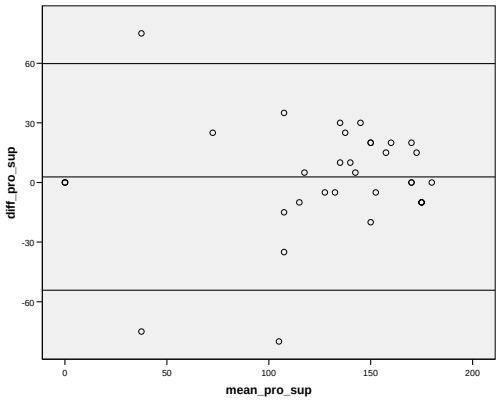


Figure 8: Bland Altman plots of the ROM measurements of the two testers, y-axis: the difference between the two testers, x-axis: the mean difference between the two testers. The line in the middle is the mean difference between the two testers, and the two other lines represent the limits of agreement

6. Main findings

- Grip strength, range of motion and performance of some daily activities were significantly impaired 1- 5 years after surgery in patients with elbow arthroplasty

- The patients reported moderate level of pain and more than half of them evaluated their elbow function as good or very good

- When compared to age-and gender-matched healthy controls, the participants had approximately a fourth of the normal grip strength. This limitation was also reflected in patient assessed measures of activities requiring grip strength, as many of the patients reported worst possible scores on items like opening a tight/new jar, and playing golf or tennis

- Only about half of the patients in this study had a flexion/extension arc equivalent to or exceeding 100°, which is considered the minimum ROM required for acceptable elbow function, indicating that they experience difficulties in performing daily activities

- It is important to be aware that even if patients report low level of pain, satisfactory level of functioning and high satisfaction with the arthroplasty, there might still be a considerable potential for improvement in specific functions and activities

- The Quick-DASH provides an important supplement and reveals important functional disabilities, such as lack of grip strength. Significant correlations with Quick-DASH were found for all measures except for range of motion. Patient assessed instruments supplement, but do not replace clinical assessed measurements such as ROM and grip-strength

- When measuring range of elbow motion, a considerable margin of error must be taken into account

- The results of this study support the need of both clinical- and patient assessed measures for optimal evaluation and management of patients with total elbow arthroplasty

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Figures and tables

Article

Pain and function in patients with rheumatic disease and elbow arthroplasty: clinical and methodological aspects

Caroline Torskog, Tarjei Lona, Terje Ugland, Kari Eikvar, Hanne Dagfinrud

Background

Rheumatoid arthritis (RA) is the most frequent inflammatory rheumatic disease, with a prevalence of 0.5-1.0 % in the adult population in western countries [10]. It is a chronic disease, resulting in joint swelling, tenderness, pain and stiffness, and may cause various degree of joint destruction [23].

It is reported that 20-50 % of RA patients show clinical and radiological evidence of elbow joint involvement [1;22]. Normal elbow function is required for positioning the hand in space, which is crucial in the performance of activities of daily living, e.g., reaching the hand to the mouth. Loss of elbow function therefore may cause severe activity limitations, and is considered more disabling than loss of shoulder or wrist function [14].

Non-surgical treatment is the first choice in patients with elbow joint involvement, including oral analgesics, intra-articular steroid injections, physical therapy and splinting. If conservative treatment no longer provides relief, total elbow arthroplasty is considered an important treatment option. Patients with RA frequently experience multiple joint involvements, and the total arm function, including shoulder and hand joints, must therefore be considered when deciding upon what is the most optimal treatment.

Joint replacement may provide a satisfactory result for patients with severe elbow joint destruction. However, due to factors related to survival of the prosthesis, patient's age and expected activity level must also be taken into consideration [22]. Studies providing results after elbow arthroplasty are mainly based on clinical assessment of impairment, mostly presented as range of motion (ROM). Only a few studies have evaluated the result of elbow arthroplasty using standardized, valid and comprehensive instruments and methods [1;11;20].

Although a variety of scores exists, few of the patient- and clinical assessed instruments available for evaluating the functional and clinical state of the elbow have been validated for measuring outcomes of elbow arthroplasty [21]. As loss of elbow function may influence health related domains on impairment level as well as on activity and participation level, tests and instruments used for monitoring and evaluating the result of elbow arthroplasty ideally should cover all these domains [25].

In a cross sectional follow-up examination 1-5 years after total elbow arthroplasty in patients operated at Diakonhjemmet Hospital, several frequently used methods and instruments for measuring elbow function were applied concurrently. The aims of this comprehensive examination was to describe the level of pain and function in patients with elbow arthroplasty, and to evaluate psychometric properties of clinical- and patient assessed instruments for evaluation of elbow function after total elbow arthroplasty.

Material and methods

As part of a routine postoperative examination of patients with total elbow arthroplasty operated at Diakonhjemmet hospital during the last 5 years (2002-2007), we developed a protocol for evaluating the properties of the most commonly used clinical- and patient assessed instruments for elbow function after a total elbow arthroplasty.

Patients 18 years or older with uni- or bilateral elbow prostheses, (primary or revision surgery), were considered for the study. All patients met for follow-up in the same short time period, independent of time since last surgery. Patients were excluded if they had a malignant disease, alcoholism, serious mental problems or cognitive impairment.

According to standard follow-up routines, the examination of the elbow joint comprised ROM, grip strength, pain and patient assessed functioning. The clinical tests were performed by a surgeon and a physiotherapist and the patients answered two standardised questionnaires.

Normative data for grip strength, ROM and DASH score were drawn from relevant publications [1;12;15].

Patient assessed instrument

The shortened disability of the Arm, Shoulder and Hand questionnaire (Quick-DASH) is shortened version of the disability of the Arm, Shoulder and Hand questionnaire (DASH), and is a patient assessed questionnaire containing 2 items addressing pain, 8 items concerning function and one addressing sleep quality in persons with any or multiple musculoskeletal disorders of the upper limp. Items are not attributed to the affected limb, but focus on the individual's ability to perform activities regardless of which arm, shoulder or hand they use. Patients self-report function on a 5- point categorical scale, from "no difficulty" to "unable to do". The scores for all items are used to calculate a total score ranging from 0 (no disability) to 100 (severe disability) [2].
The full length DASH is validated for upper extremity complaints in patients with RA [18]. Studies have demonstrated that the DASH can be replaced with the Quick-DASH [2;2;6]

A patient global assessment score was also included, where the patients rated their total elbow function on a 5-point categorical scale ranging from 1 to 5 (5 equals worst function).

Combined patient- and clinical assessed instruments

The American Shoulder and Elbow Surgeons Elbow assessment form (ASES) is a standardized elbow evaluation form including both a patient evaluation and a clinical assessment of elbow function. The ASES patient assessment has three subscales; pain, function and satisfaction [9]. The pain scale contains 5 questions in which pain in the elbow-region is rated on a 10 point categorical scale (10 equals worst pain ever), and a body-figure where the patient is asked to mark the location of the pain. The function scale consists of 10 items asking patients to rate performance of daily activities on a 0 to 3 categorical scale. ASES also includes a single item where the patient is asked to rate their satisfaction with surgery on a 0-10 scale (10 = very satisfied) [9]. The clinician assessed part contains evaluation of joint motion, recorded with the use of a goniometer. The ASES also includes evaluation of elbow joint stability and muscle strength, but these scales were not used in this study.
Weighting of the various subscales and a standardised computations of a sum scale of ASES have not been reported [11]. In this study, three sum scores were calculated; for pain, for function (including the patient- and the clinical assessments of total elbow function), and for satisfaction.

Mayo Elbow Performance Score (MEPS) is a clinician rated assessment of pain, range of motion, stability and function on 0-100 scale (100 best score) [13]. Standard terminology and information considering how each item should be rated is lacking. The response items are dichotomous (present/ or absent) and the instrument is therefore less able to discriminate between different levels of functional disability[13]. Even if MEPS is a widely used outcome measure, the knowledge of the instruments psychometric properties is scarce [4;20].

Clinical assessed measures

Grip strength was measured with the Grippit instrument**.** Grippit measure the maximum momentary force and the mean force over a set period of time (10 seconds). The instrument consists of a grip device, an electronic unit and an adaptor for connection to a power supply. Grippit is commonly used for patients with rheumatic diseases and has been tested for psychometric properties for patients with RA, but has not been validated for patients with total elbow arthroplasty [3;15;24].

Statistical analysis

The socio-demographic and clinical variables were presented as mean and standard deviation (SD) for continuous variables whereas frequencies (percentage) were calculated for categorical variables. Clinical measures (ROM and grip strength) were visualised with scatter-plots and compared with age and gender matched population based scores.

In order to explore level of function in different activities, the single items of the Quick-DASH were presented with minimum and maximum scores. We also examined possible floor and ceiling effects, and considered these as present if more than 15% of the respondents achieved lowest or highest possible score, respectively. Internal consistency (how well a set of items measures a uni-dimensional construct) was tested by Cronbach's alpha coefficient and calculated for all measures, except from the MEPS, due to the mix of assessment methods within this measure. A Cronbach's alpha >0.70 was considered acceptable [17].

Correlations between measures were examined by Pearson correlation coefficient (r), and the coefficients of determination were used to calculate shared variance between the different scores and the Quick-DASH. As all assessments measure elbow function, we hypothesized that the correlation coefficients between the scores would be high ($r \geq 0.7$). The Quick-

DASH was regarded as closest to a gold standard and was used as dependent variable in a multiple regression analysis.

For comparison, all scales were transformed to 0-100, 100 representing best function.

For statistical analysis, Statistical Program for Social Services, version 15.0, SPSS Inc., Chicago, USA (SPSS for Windows (version 16.0)) was used. P-values below 0.05 were considered to be significant.

Results

Thirty two patients were included in this study, 24 women and 8 men, mean age 68.5 min-max years. Mean (SD) duration of the current arthroplasty was 3.1 (1.2) years. The arthroplasty was revised one or more times in 56 % of the patients. Twenty-four participants had RA; the other participants had other rheumatic diseases or posttraumatic arthritis.

The patients reported moderate level of pain (mean (SD) 77 (22)), while the mean (SD) upper arm function was 47 (20) for the Quick-DASH. Further, the mean (SD) satisfaction score was 69 (25), with 56% of the patients rating their elbow function as good or very good (Table 1a,1b).

The mean (SD) flexion/extension arc was 97.6 ° (21.4) (compared to 140 ° in a healthy population) and the mean (SD) maximal grip strength was 118 (93) N for men and 54 (33) N for women (compared to 430 N and 220 N, respectively in healthy men and women), indicating impaired function concerning both range of motion and grip strength (Fig 1-2).

The sum score of the quick-DASH was normally distributed, but single items showed ceiling effects for grip strength activities (open jar and recreational activities) and floor effects for the item addressing interference of arm function with normal social activities (47 % and 44 % respectively) (Table 1a). The internal consistency of the Quick -DASH scores were acceptable (Cronbach's alpha coefficient 0.90) (Table 1a).

In a multivariate regression model, grip strength contributed significantly ($p= 0.03$), while ROM did not contribute to the variation ($p=0.81$) of the Quick-DASH score. Due to the well known difference in grip strength between men and women, the multivariate analysis was performed for men and women separately, and reported in details only for women (Table 2).

Neither grip strength nor ROM contributed significantly for men, but the results should be interpreted with caution, due to the small sample size.

Significant correlations with Quick-DASH were found for all measures ($p<0.01$), except for ROM ($r= 0.2$, $p=0.35$). ROM explained 3% of the variance in the patient assessed function score, while grip strength explained 29 %.

Discussion

Clinical evaluation

This comprehensive evaluation of patients with elbow arthroplasty showed that grip strength, range of motion and performance of daily activities were significantly impaired 1-5 years after surgery. However, the patients reported moderate level of pain and more than half of them evaluated their elbow function as good or very good.

When compared to age-and gender-matched healthy controls, the participants in this study had approximately a fourth of the normal grip strength. It is well known that RA patients suffer from impaired hand function. In a Swedish study, the Grippit scores for women with RA were barely higher than in our joint replacement cohort [15]. Limited grip strength is expected in patients with established RA, and it is important to notice that elbow joint replacement does not seem to improve hand function. The limited grip force was also reflected in patient assessed measures of activities, as many of the patients reported worst possible scores on items requiring good hand function, like opening a tight/new jar, and playing golf or tennis. The strong influence of grip strength on daily activities was further confirmed in a regression model, showing that grip strength was more important than range of motion in explaining the variation of the Quick-DASH score. These results are in concordance with another study, in which grip force was found to be the strongest regressor of activity limitations [24]. For optimal rehabilitation of patients with elbow joint involvement, an enhanced focus on muscle strength may be recommended.

In this study, only 17 of the patients had a ROM equivalent to or exceeding 100° , which is considered the minimum ROM required for acceptable elbow function [16] [12] . These results, as well as the scores from the functional scales, confirm that many of the participants experience difficulties in performing daily activities. However, despite these physical

limitations, patients reported to be fairly satisfied with the result of their elbow arthroplasty. Further, patients reported the interference of the elbow affection with social activities to be surprisingly low. This is in contrast with results of other studies, in which of persons with RA report that they often experience restrictions in participation and social roles [5 19]. One reason for these differences may be that the elbow arthroplasty was performed in a later disease stage in our participants, and that they have during a long-term disease course learned to compensate for the loss of specific functions by developing adaptive strategies.

Evaluation of instruments

Validity is an elusive concept measured by a variety of methods. In this study a construct validation process was applied, by comparing measures designed to assess the same concept of function. The included measures of function showed similar properties, but Quick-DASH also provided important information by revealing limited hand function.

Significant floor effects were found for single items of the Quick-Dash involving grip-strength. In accordance with this finding, significant correlation was also found between the Quick-DASH and grip-strength ($p<0.004$). Thus, there seem to be a strong association between grip strength and elbow function, and examination of grip strength should therefore be part of a complete assessment of the results of elbow arthroplasty. In contrast, the association between the Quick-DASH and ROM scores was weak ($p=0.35$), indicating that limited elbow motion has less impact on activity performance compared to the impact of reduced grip strength. This was also confirmed in a multiple regression model with the Quick- DASH as dependent variable.

All the patient-assessed measures included in this study comprise a combination of items addressing pain and function. Still, the mean Quick-DASH sum score was lower (worse function) than the other scores. This is probably due to unequal weighting of function and pain in the different studies, underlining that pain and function are two different concepts, even if they are correlated [1 21]. Pain is regarded as the most important factor affecting health perception. It is therefore not surprising that patients' report to be satisfied with the operation based on their perceived pain reduction [7]. However, in order to optimise the benefit of the intervention, patients' assessment of general function and specific joint function should also be included when the outcome is evaluated.

The concurrent use of both clinical- and patient assessed measures allow for a comparison of the different perspectives of patients and health professionals. The discrepancy in the scores derived from clinical- and patient assessed measures demonstrated in this study is supported in other studies and is a well known phenomenon in chronic diseases [1 21]. It is important to be aware that even if patients report low level of pain, satisfactory level of functioning and high satisfaction with the arthroplasty, there might still be a considerable potential for improvement in specific functions and activities.

A limitation of this study is the uncontrolled, cross-sectional design. Longitudinal studies are required to monitor disease course and to examine the responsiveness of the outcome measures. However, the comprehensive examination performed in this study allowed for a thorough description of function in patients with elbow arthroplasty.

It has been shown that patients' view does not necessarily correlate with clinical data, and studies relying on only clinical measures may therefore be in risk of underestimating the high level of satisfaction among the patients, which may be decisive in determining future utilization of health care resources [1;8]. On the other hand, only to use patient assessed measures may lead to an over-optimistic evaluation of the functional outcome, with the risk of not utilising the true potential for improvement. To ensure optimal evaluation and management of patients with total elbow arthroplasty, one should therefore use both clinical- and patient reported measures.

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Table 1a: Patient assessed outcome measures for 32 patients with total elbow arthroplasty

Instrument/ measures	Median	Min/ max
Patient assessment Quick-DASH single items (1-5, 5 worst possible score)		
• Open tight/ new jar*	4.5	2-5
• Heavy household cores	4	1-5
• Carry bag/ briefcase	3	1-5
• Wash back	4	1-5
• Use knife/ cut food	3	1-5
• Recreational activities with use of arm/shoulder/ hand*	4	1-5
• Interference of arm/ shoulder/ hand with normal social activities (last week)**	2	1-5
• Limited in work/ other regular ADL as a result of arm/ shoulder/ hand (last week)	3	1-5
• Arm, shoulder or hand pain	3	1-4
• Tingling in arm/shoulder/ hand	3	1-4
• Sleeping difficulties because of arm/ shoulder/ hand (last week)	2	1-4

Patient assessment sum score (0-100, 100 best health)	Median/ mean (SD)	Min/ max	Cronbach's alpha
Quick-DASH	47.7 / 47.2 (19.7)	14-97	0.90
ASES pain	80 / 77 (21.6)	28-100	0.88
ASES satisfaction	65 / 69.4 (25.4)	20-100	
Patient Global Assessment of elbow function (1-5, 5 very bad function)	2 / 2.4 (0.9)	1-4	
Patient- and clinical assessment combined sum score (0-100, 100 best health)			
ASES function	61.2/52.3 (29.7)	0-100	0.94
MEPS total	62.2/62.8 (19.7)	34-100	

*Ceiling effect : open tight/ new jar 46.9 %, recreational activities with use of arm/shoulder/ hand 40.6%

**Floor effect: interference of arm/ shoulder/ hand with normal social activities? 43.8 %

Table 1b: Clinical assessed outcome measures for 32 patients with total elbow arthroplasty

Clinical assessment	Mean (SD)	Min/ max
ROM flex/ext arc °	97.6 (21.4)	30-135
Grippit max (N)	67.9 (56.4)	8-293
Grippit mean (N)	55.1 (51.8)	5-276

Quick-DASH: Short version of the Disabilities of Arm, Shoulder and Hand function

ASES: American Shoulder and Elbow Score, function, pain, satisfaction, function

MEPS: Mayo Elbow Performance Score

ROM: range of motion

°: degrees of flexion/ extension arc

N: Newton

Figure 1: Scatter plot mean (SD) ROM (flexion and extension) for the elbow population. The dotted line shows range for functional elbow (100°)

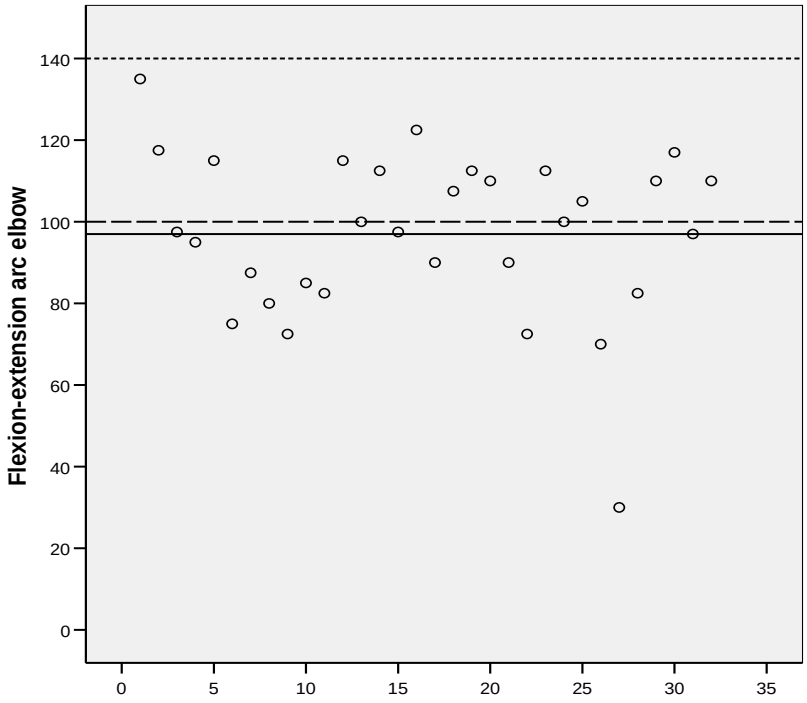


Figure 2: Maximal grip strength (Newton) for men (118) and women (54) with elbow arthroplasty (straight lines) normal grip strength for men (432) and women (222) (dotted lines)

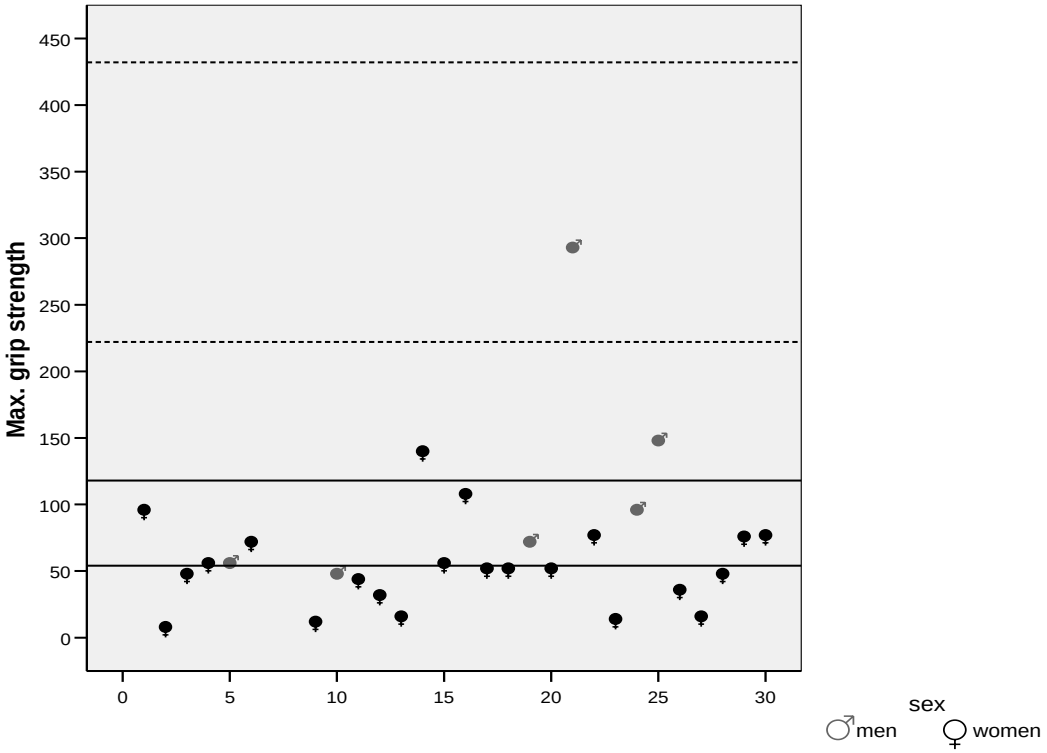


Table 2: Correlations and multivariate regressions of the patient-and clinical assessed instruments

Correlations (Pearsons r)			Multivariate regressions		
Instruments/ measurements	Quick-DASH	p-values		ß (CI)	p-values
ASES function	.797	≤ .0001	Age	-.20 (-.65,.23)	.34
ASES pain	.479	≤ .0001	Grip strength	.21 (.03, .39)	.03
MEPS	.811	.009	ROM (flexion-extension)	.034 (-.25, .32)	.81
Grip strength	.541	.004			
ROM (flexion-extension)	.178	.348			

Quick-DASH: Short version of the Disabilities of Arm, Shoulder and Hand function

ASES: American Shoulder and Elbow Score

MEPS: Mayo Elbow Performance Score

ROM: range of motion

Appendix

I: The Quick-DASH

II: The Mayo Elbow Performance Score (MEPS)

III: The American Shoulder and Elbow Surgeon assessment form (ASES)

IIII: Patient Global Assessment of total elbow function

Appendix I

Kvikk-DASH

Navn: født: Dato:

	Ingen vanskelig-heter	Lette vanskelig-heter	Middels vanskelig-heter	Svære vanskelig-heter	Umulig å gjøre
1. Åpne et nytt syltetøyglass	☐	☐	☐	☐	☐
2. Utføre tungt husarbeide (f.eks. vaske gulv eller vegger)	☐	☐	☐	☐	☐
3 Bære dokumentmappe eller handlebose	☐	☐	☐	☐	☐
4. Vaske ryggen	☐	☐	☐	☐	☐
5. Skjære opp mat med kniv	☐	☐	☐	☐	☐
6. Fritidsaktiviteter som krever en viss kraft eller styrke i arm, skulder eller hånd (f.eks spille golf, bruke hammer, spille tennis)	☐	☐	☐	☐	☐

7. I hvilken grad har dine arm , skulder eller håndproblemer hemmet din vanlige omgang med slektninger, venner, naboer eller andre den siste uken? (Sett ett kryss.)

☐ Ikke hemmet i det hele tatt ☐ Litt ☐ Moderat ☐ Ganske mye ☐ Ekstremt

8. Var du begrenset på grunn av dine arm , skulder eller håndproblemer i ditt arbeide eller andre vanlige daglige aktiviteter i løpet av den siste uken?

☐ Ikke begrenset i det hele tatt ☐ Litt ☐ Moderat begrenset ☐ Svært begrenset ☐ Umulig

Angi alvorlighetsgraden av de følgende symptomene i den siste uken

	Ingen	Lett	Moderat	Sterk	Ekstrem
9. Smerte i arm, skulder eller hånd	☐	☐	☐	☐	☐
10. Prikking ("mauring", "sovnet") arm, skulder eller hånd	☐	☐	☐	☐	☐

11. Hvor mye vansker har du hatt den siste uken med å sove på grunn av smerte i arm, skulder eller hånd?

☐ Ingen vansker ☐ Litt vansker ☐ Moderate vansker ☐ Betydelige vansker ☐ Har ikke fått sove

10.04 Vilh.Finsen@ntnu.no

Appendix II

The Mayo Elbow Performance Score 0-100, 100 best (MEPS)		
Funksjon	Poeng	Definisjon (poeng)
Smerte	45	Ingen (45) Mild (30) Moderat (15) Alvorlig (0)
Bevegelighet	20	>100 ° (20) 50-100 ° (15) <50 ° (5)
Stabilitet	10	Stabil (10) Moderat instabilitet (5) Stor instabilitet (0)
Funksjon	25	Gre hår (5) Spise selv (5) Utføre hygiene (5) Kneppe skjorte (5) Snøre sko (5)
Totalt	100	
Classification: Excellent >90, Good 75-89, Fair 60-74, Poor <60 [52]		

Appendix III

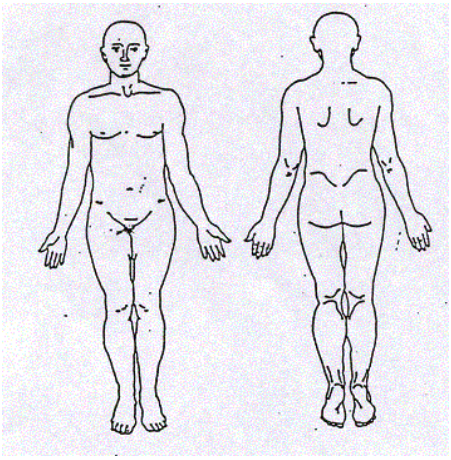
American Shoulder and Elbow Surgeons assessment form (ASES)

Id. nr:	**Dato:**
Alder:	**Kjønn:**
Diagnose:	**Opr. albu:**
Dominant hånd:	**Opr. dato:**

ASES Pasient rapportert smerte

Har du smerter i albuen? (kryss av)	☐ JA	☐ NEI

Markèr på figuren under hvor du har smerter:



ASES pasient rapportert smerte

HVOR STERK ER SMERTEN I ALBUEN DIN?

(sett ring rundt det tallet som stemmer mest med din smerte)

NÅR SMERTEN ER PÅ SITT ALLER VERSTE

0 1 2 3 4 5 6 7 8 9 10

|----------|

Ingen smerte Verst tenkelige smerte

NÅR ARMEN ER I RO

0 1 2 3 4 5 6 7 8 9 10

|----------|

Ingen smerte Verst tenkelige smerte

NÅR DU LØFTER EN TUNG GJENSTAND

0 1 2 3 4 5 6 7 8 9 10

|----------|

Ingen smerte Verst tenkelige smerte

NÅR DU MÅ BØYE ALBUEN MANGE GANGER ETTER HVERANDRE

0 1 2 3 4 5 6 7 8 9 10

|----------|

Ingen smerte Verst tenkelige smerte

OM NATTEN

0 1 2 3 4 5 6 7 8 9 10

|----------|

Ingen smerte Verst tenkelige smerte

ASES Pasient rapportert funksjon								
Sett ring rundt det tallet som passer best **0 = Ikke i stand til det 1 = veldig vanskelig 2 = litt vanskelig 3 = ikke vanskelig**								
	Høyre				**Venstre**			
Kneppe skjorte / bluse helt opp	0	1	2	3	0	1	2	3
Gå på toalettet	0	1	2	3	0	1	2	3
Gre håret	0	1	2	3	0	1	2	3
Knytte skoene	0	1	2	3	0	1	2	3
Spise (bruke kniv og gaffel)	0	1	2	3	0	1	2	3
Bære en tung gjenstand	0	1	2	3	0	1	2	3
Reise deg fra stol ved å skyve fra med armene	0	1	2	3	0	1	2	3
Utføre tungt husarbeid	0	1	2	3	0	1	2	3
Vri om en nøkkel	0	1	2	3	0	1	2	3
Kaste en ball	0	1	2	3	0	1	2	3
Utføre ditt vanlig arbeid	0	1	2	3	0	1	2	3
Gjøre sports-/ fritidsaktiviteter	0	1	2	3	0	1	2	3

Pasient rapportert tilfredshet
Hvor tilfreds er du med albuproteseoperasjonen? (Sett ring rundt det tallet som du synes passer best) 0 1 2 3 4 5 6 7 8 9 10
|----------| Ikke tilfreds i det hele tatt Veldig tilfreds

Klinisk vurdering			
BEVEGELIGHET			
Aktive bevegelsesutslag (grader)	**Høyre**	**Venstre**	
FLEKSJON			
EKSTENSJON			
FLEKSJON + EKSTENSJON (arc)			
PRONASJON			
SUPINASJON			
PRONASJON + SUPINASJON (arc)			

STABILITET

0 = ingen instabilitet 1 = lett instabilitet med normalt stoppfølelse 2 = moderat instabilitet uten stoppfølelse 3 = stor instabilitet

INSTABILITET	HØYRE	VENSTRE
Valgus	0 1 2 3	0 1 2 3
Varus	0 1 2 3	0 1 2 3
Posterolateral rotasjon	0 1 2 3	0 1 2 3

STYRKE

0 = ingen kontraksjon 1 = antydning til kontraksjon 2 = bevegelse med tyngdekraften eliminert 3 = bevegelse mot tyngdekraften 4= bevegelse med noe motstand 5 = bevegelse med normal kraft

Blir testen påvirket av smerte? ja/nei	HØYRE	VENSTRE
Fleksjon		
Ekstensjon		
Pronasjon		
Supinasjon		

Gripe styrke- Grippit (Newton)

Hø: max: **gj.snitt:**

Ve: max: **gj.snitt:**

Patient Global Assessment of elbow function **Appendix IIII**

TOTALVURDERING AV ALBUEFUNKSJON

Hvordan vil du alt i alt vurdere din albuefunksjon?

☐	☐	☐	☐	☐
veldig god	god	middels	dårlig	veldig dårlig