

# Early Mobilization and Functional Discharge Criteria Affecting Length of Stay after Total Elbow Arthroplasty

Časná mobilizace a funkční kritéria pro propuštění ovlivňující délku pobytu po totální endoprotéze lokte

A. PRKIĆ<sup>1</sup>, J. VIVEEN<sup>1</sup>, B. THE<sup>1</sup>, K.L.M. KOENRAADT<sup>2</sup>, D. EYGENDAAL<sup>1,3</sup>

<sup>1</sup> Department of Orthopedic Surgery, Amphia Hospital, Breda, The Netherlands

<sup>2</sup> Foundation for Orthopedic Research, Care & Education, Amphia Hospital, Breda, The Netherlands

<sup>3</sup> Department of Orthopedic Surgery, University of Amsterdam, Amsterdam, The Netherlands

## ABSTRACT

### PURPOSE OF THE STUDY

Decline in length of stay is of growing interest for patients, doctors and health insurances. The aim of our study was to assess the safety and length of stay after omission of casting, start of early mobilization and implementation of functional discharge criteria after total elbow arthroplasty (TEA).

### MATERIAL AND METHODS

We retrospectively reviewed all patients' records who received a Coonrad-Morrey TEA in the period from January 1<sup>st</sup>, 2011 to December 31<sup>st</sup>, 2018. From these records, indications, demographic information and complications were derived. Length of stay was calculated from the hospital administration. Patients were divided in three groups to evaluate the two changes in post-operative care.

### RESULTS

In total 125 patients receiving 126 Coonrad-Morrey TEAs were included with a mean length of stay of 5.5 days (range 2–23) for the entire group. Omitting a post-operative cast led to decline in length of stay from 6.2 to 5.4 days ( $p < 0.001$ ). Introduction of functional discharge criteria in August 2017 declined mean length of stay to 3.8 days ( $p < 0.001$ ). The surgical technique (triceps-on versus triceps-off) was not a confounder ( $p = 0.20$ ). Range of motion after one year was not significantly different between groups.

### DISCUSSION

The length of stay declined after omission of a cast, and declined further after introducing functional discharge criteria. Since no higher complication rates were observed, the shortening of length of stay appears to be safe. This is in line with other fast-track programs, i.e. for hip and knee arthroplasty. The surgical technique used were not a confounder for the shortened length of stay, which further adds to the safety of the functional discharge criteria.

### CONCLUSIONS

Omitting a cast and splint as regular post-operative treatment reduced the length of stay significantly without leading to more complications. Introduction of functional discharge criteria lowered the length of stay further without more complications.

**Key words:** fast track rehabilitation, cast, total elbow arthroplasty, length of stay, discharge, complications.

## INTRODUCTION

The introduction of fast-track total hip and knee arthroplasty has increased patient satisfaction and reduced length of stay at the hospital (9, 12). A shorter hospital stay is therefore valuable for patients, as well as health-care insurances. In multiple hospitals, the introduction of 'functional discharge criteria' after hip and knee arthroplasty were successful with a reduction in hospital stay without an increase of complications (9, 12).

In analogy of total hip and knee surgery, we implemented 'functional discharge criteria' for total elbow arthroplasty (TEA) patients. These criteria are adequate mobility to resume the activities of daily living, sufficient pain control for physiotherapy exercises and a wound that addresses no further specialized care. The goal was to reduce hospital stay, without an increase of

complications with comparable functional outcomes. Previous studies have shown that TEA can be performed safely in an outpatient procedure and even in an outpatient setting for selected patients (1, 5, 14). However, the patients who were included in those analyses had proven to be able to be discharged the same day and all other patients were not included in the analyses.

Therefore, the aim of our study is to perform an analysis of our own practice since 2011, which has undergone these two major changes in peri-operative care. To avoid the aforementioned risk of inclusion bias, all patients receiving a primary TEA will have to be included. First, a comparison will be performed for the influence of a cast after surgery. Second, the implementation of the functional discharge criteria will be analyzed.

We hypothesized that an arm without a cast will facilitate activities in daily life more easily and will reduce the length of stay in the hospital. To secure safety of early mobilization without a cast, we compared wound leakage and other complications with the hypothesis that wound leakage and other complications are not affected by early mobility after surgery. With implementation of the functional discharge criteria, we expect no difference in post-operative complications, yet we expect length of stay to decline further.

## MATERIAL AND METHODS

### Patients

We reviewed patients' records who received a primary Coonrad-Morrey (Zimmer®, Warsaw, USA) TEA in the period from January 1<sup>st</sup>, 2011 to December 31<sup>st</sup>, 2018. All primary Coonrad-Morrey TEAs were included in this retrospective analysis. This was defined as all patients who did not have any (hemi)arthroplasty in the affected elbow and received a Coonrad-Morrey TEA. From the patient records, demographic information, indications and complications were collected.

### Study design

Length of stay was calculated from the patients' records and double-checked with the hospitals' administration in case no medical annotation was written in the patient file on the day of discharge. Day of surgery was defined as day 0 as patients are not hospitalized the day before surgery.

Three cohorts were made; first the index cohort, which consists of all patients that received an arthroplasty before January 1<sup>st</sup>, 2016 as we then changed our institutional policy to omit casting post-operatively. The semi-circular casts in 60–90 degrees of elbow flexion, applied directly after the wound was closed, were used up to December 2015 with the hypothesis wound healing in the first days after surgery would be promoted (10). The cast was applied for three days, and once removed the rehabilitation process with the physiotherapist could be started. For the patients with a triceps-flap approach, passive motion was promoted for 6 weeks, and for patients with a triceps-on approach active motion was promoted directly after surgery. All patients in this cohort received a night splint for 6 weeks.

Second, a cohort of patients without functional discharge criteria was labeled as 'empirical discharge'.

This group consists of all patients receiving an arthroplasty between January 1<sup>st</sup>, 2016 and August 1<sup>st</sup>, 2017. During the empirical discharge period, patients were informed orally and with a booklet that their hospitalization would last for 5 to 7 days, depending on the aspect of the wound. Since a cast was omitted, absorbable gauzes with cotton wool and a pressure bandage that permitted limited elbow movements were used for three days, and changed when needed. A night splint for 6 weeks was provided to avoid undesirable or extreme movements. With the pressure bandage, limited range of movement was promoted with the physiotherapist; passive range of motion

exercises for triceps-flap approaches and active range of motion exercises for triceps-on approaches.

Third, a cohort with functional discharge criteria was defined with all patients who received a primary total elbow arthroplasty since August 2017. From this time, all patients were discharged after fulfilling the functional discharge criteria, which were defined as adequate mobility to resume activities of daily living, sufficient pain control for physiotherapy exercises and a wound that addresses no further specialized care. During the pre-operative counselling at the outpatient clinic, patients were informed orally and with a booklet about the functional discharge criteria. Patients still were not discharged as long as the wound had leakage and thus required specialized wound care with absorbable dressings, or showed signs of infection. These patients received a bulky dressing of pressure bandage for three days, what could be removed by the patients themselves after discharge took place before three days. Rehabilitation consisted of passive exercises for triceps-flap approaches and active exercises for triceps-on approaches.

For all patients, physiotherapy was provided on all days of the week during hospitalization. The hospital's physiotherapist provided a protocolled handover to the patients' own physiotherapists, and consisted of range of movement training and for the triceps-flap patients, strength improvement starting after 6 weeks. Follow-up was performed on the outpatient clinic after 2 weeks, 3 months and 1, 3, 5, 7 and 10 years in all cohorts. On all follow-up visits complications were asked to patients and clinical examination was performed. Because of the retrospective design of this study, Institutional Review Board approval was waived.

### Statistical analyses

Length of stay between cohorts is compared using the Mann-Whitney U test as the Shapiro-Wilk test showed a non-normal distribution of data. Complications, such as wound leakage, were compared using the Chi-square test. To assess the influence of the weekday on length of stay, the Chi-square test was used. The risk factors and possible confounders for length of stay and wound leakage were tested using ANOVA. Statistical significance was set at the level of  $p < 0.05$ .

## RESULTS

In total, 125 consecutive patients received 126 primary elbow arthroplasties performed using the Coonrad-Morrey TEA between January 1<sup>st</sup>, 2011 and December 31<sup>st</sup>, 2018. One patient received bilateral arthroplasties in two separate procedures, which counted as two separate arthroplasties throughout this study. Mean duration of follow-up was 45 months. The index cohort consisted of 70 patients, the cohort with empirical discharge consisted of 31 patients and the functional discharge criteria cohort of 25 patients. Demographic and surgical data are shown in Table 1. Indications were predominantly secondary osteoarthritis following trauma, followed by elbow joint destruction because of rheumatoid arthritis.

Rheumatoid arthritis as a comorbidity was present in 31% of total cases. One olecranon osteotomy was performed in a trauma case with an olecranon fracture that was used as an access portal. More than half of the patients (60%) had undergone previous surgery on the affected elbow. Most frequent reported previous surgeries were open reduction and internal fixation of a radial head, humeral and/or ulnar fracture, in 41% of patients.

Comparing the index cohort with the non-casting cohort revealed that the length of stay was significantly reduced from a mean of 6.2 to 5.4 days ( $p < 0.001$ ). The number of complications was comparable between our casting and non-casting groups ( $p = 0.29$ ). When focus-

ing on wound leakage requiring specialized wound care, no clinical nor statistical difference was seen (Table 2).

The introduction of functional discharge criteria led to a decline in length of stay from 5.4 to 3.8 days ( $p < 0.001$ ). As shown in Table 3, the demographic and medical factors were not different between the cohorts. In the functional discharge criteria group, one patient visited the outpatient clinic before the regular appointment after two weeks because of wound leakage on day 8; no signs of infection were present, and an expectant policy was provided.

Weekday of surgery did not influence the length of stay on the whole cohort ( $p = 0.87$ ), nor on the non-cast group ( $p = 0.31$ ) nor on the functional discharge group ( $p = 0.82$ ). The surgical technique used was not a significant confounder on length of stay ( $p = 0.20$ ), even though since 2014 the triceps-on technique is used more often (Tables 2 and 3).

Complications occurred in 25% of cases; most were transient ulnaropathies (14% of total cases) and blistering of the skin (10% of total cases). From the eighteen ulnaropathies, two have proven permanent sensory and motoric malfunction. Blistering of the skin was present in 10% of patients with a cast, in 6% of patients without a cast and in 12% of patients with the functional discharge criteria ( $p = 0.76$ ) and blistering showed not to be related to diabetes ( $p = 0.31$ ), rheumatoid arthritis ( $p = 0.83$ ) nor smoking ( $p = 0.57$ ) in this study.

In five cases a deep infection occurred. In one of those patients, it occurred after a bushing exchange because of failure of the hinge mechanism. Two patients developed an aspiration pneumonia, which accounted for both fatalities; one patient was resuscitated without success, and one patient died because of sepsis and multi-organ failure after aspiration pneumonia.

Persistent wound leakage on day 4, 5, 6 and 7 post-operatively was noted in respectively 17, 10, 7 and 4 patients. From these patients with persistent wound leakage, one patient developed a deep prosthetic infection requiring lavage and antibiotic treatment. From the eight patients with a superficial or deep infection, two patients had persistent wound leakage on day 4.

After one year, range of motion arcs of the casting group was 114 degrees for flexion and extension ( $N = 52$ ,  $SD 20$  degrees), for the non-casting group 113 degrees ( $N = 22$ ,  $SD 12$  degrees) and for the functional discharge criteria group 119 degrees ( $N = 4$ ,  $SD 18$  degrees). The flexion-extension range of motion did not differ ( $p = 0.87$ ). Pronation and supination arcs of the casting group was 114 degrees for flexion and extension ( $N = 52$ ,  $SD 24$  degrees), for the non-casting group 129 degrees ( $N = 20$ ,  $SD 29$  degrees) and for the functional discharge criteria group 155 degrees ( $N = 4$ ,  $SD 18$  degrees). The pronation-supination range of motion did not differ ( $p = 0.12$ ).

## DISCUSSION

The aim of this study was to evaluate two changes in our post-operative regimen after TEA. First, the com-

Table 1. Demographic and surgical data of the whole cohort of primary total elbow arthroplasties. Percentages are given between parentheses

<b>Mean age [SD]</b>	69 [7.6]
<b>Gender</b>	18 male, 108 female
<b>Indication</b>	
Primary osteoarthritis	8 (6)
Secondary osteoarthritis	71 (56)
Rheumatoid arthritis	33 (26)
Fracture	12 (9)
Metastasis	2 (2)
<b>Surgical approach</b>	
Triceps-on	43 (34)
Triceps-flap	82 (65)
Olecranon osteotomy	1 (1)
<b>Previous surgery (% of total group)</b>	75 (60)
Arthroscopy	5 (4)
Arthrotomy	11 (9)
Fracture	51 (41)
Ulnar nerve release	2 (2)
Luxation	1 (1)
<b>Comorbidities</b>	
ASA classification	
1	4 (3)
2	79 (63)
3	43 (34)
4	0
Rheumatoid arthritis	39 (31)
Diabetes	9 (7)
Smoking	17 (14)
Therapeutic anticoagulant use	13 (10)
<b>Length of stay in days [SD]</b>	5.5 [2.6]
<b>Complications</b>	
No complications	92 (73)
Transient ulnaropathy	16 (13)
Blistering of skin	12 (10)
Deep prosthetic infection	5 (4)
Fissure ulna	2 (2)
Permanent ulnaropathy	2 (2)
Transient radiopathy	1 (1)
Superficial wound infection	3 (2)
Pneumonia	2 (2)
30-day mortality	2 (2)
Triceps weakness	1 (1)
Hematoma evacuation	1 (1)
Hematoma, bandage	1 (1)

ASA: American Society of Anaesthesiologists. SD: standard deviation

plication rate without a cast after surgery, most notably wound leakage, does not differ without a cast. Second, a reduction of length of stay after implementation of functional discharge criteria led to a reduction of almost three full days. Therefore, we can conclude that omitting a cast after primary TEA is safe, and implementing functional discharge criteria provide a safe method to reduce length of stay after primary TEA further.

The elbow casts were used in the past to prevent wound leakage in the first few days after surgery (10). From January 2016 on, patients did not receive a cast post-

operatively, unless the type of surgery required a cast (i.e. after revision surgery or periprosthetic fractures). The decision to change to a drape instead of a cast implied the possibility to start more early with physiotherapy and rehabilitation. Early physiotherapy has been proven to be beneficial in hip and knee arthroplasty, especially in the early phase after surgery (2, 7, 9). Besides, before patients are ready for discharge, a basic level of independency in activities of daily living has to be present in our opinion. As casting after surgery provided no benefits in neither diminishing persistent

Table 2. Comparison of the groups of patients with and without a cast after surgery

	Index cohort (n = 70)	No cast (n = 31)	p-value
<b>Mean age [SD]</b>	69 [7.8]	70 [6.6]	0.560
<b>Gender</b>	10 male, 60 female	6 male, 25 female	0.662
<b>Indication</b>			0.628
<i>Primary osteoarthritis</i>	7	1	
<i>Secondary osteoarthritis</i>	37	19	
<i>Rheumatoid arthritis</i>	19	8	
<i>Fracture</i>	5	3	
<i>Metastasis</i>	2	-	
<b>Surgical approach</b>			<0.001
<i>Triceps-on</i>	8	27	
<i>Triceps-flap</i>	61	73	
<i>Olecranon osteotomy</i>	1	1	
<b>Previous surgery</b>			0.088
<i>Arthroscopy</i>	2	4	
<i>Arthrotomy</i>	10	-	
<i>Fracture</i>	17	7	
<i>Ulnar nerve release</i>	1	2	
<i>Luxation</i>	1	-	
<i>External fixation</i>	2	-	
<i>Radial head surgery</i>	6	5	
<b>Comorbidities</b>			0.288
<i>ASA classification</i>			
1	2	3	
2	49	67	
3	19	31	
4	0	-	
<i>Rheumatoid arthritis</i>	23	10	0.572
<i>Diabetes</i>	5	2	0.633
<i>Smoking</i>	13	4	0.348
<i>Therapeutic anticoagulant use</i>	5	5	0.151
<b>Length of stay in days [SD]</b>	6.2 [2.0]	5.4 [3.4]	<0.001
<b>Wound leakage (days)</b>			
4	8	5	0.529
5	6	1	0.433
6	3	0	0.551
7	1	1	0.521
<b>Complications</b>			0.292
<i>Transient ulnaropathy</i>	12	2	
<i>Permanent ulnaropathy</i>	2	-	
<i>Transient radiopathy</i>	1	-	
<i>Superficial wound infection</i>	2	-	
<i>Deep prosthetic infection</i>	1	2	
<i>Fissure ulna</i>	2	-	
<i>Hematoma evacuation</i>	1	-	
<i>Triceps weakness</i>	1	-	
<i>Pneumonia</i>	-	2	
<i>30-day mortality</i>	-	2	

wound leakage nor other complications, we opt there is no room for regular casting after TEA using the Coonrad-Morrey prosthesis in our hospital. We believe that faster return home leads to less hospitalization, more self-independence and less intervention on patient's habits, which will be experienced as positive by the patients in analogy to total hip and total knee replacement patients (6, 12).

Implementing functional criteria instead of regular admission days leads to further decline in hospitalization. In our experience, this seems to be valuable for

both patients, who return home earlier, and to the hospital, as the inpatient beds can be used for other patients (7, 9, 13). Discharge when meeting functional discharge criteria to optimizes patients' expectations, what may result in higher satisfaction scores (12).

The complication rate of a shorter hospital stay is not higher than after a longer hospital admission and no more adverse events such as wound problems or blistering of the skin were seen, what implies that a shorter length of stay is not harmful. In addition, when the whole cohort is divided into three subgroups the length of stay declines

Table 3. Comparison of the groups with empirical discharge after 5 to 7 days and the group with functional discharge criteria

	No cast (n = 31)	Functional discharge (n = 25)	p-value
<b>Mean age [SD]</b>	70 [6.6]	71 [8.3]	0.541
<b>Gender</b>	6 male, 25 female	2 male, 23 female	0.276
<b>Indication</b>			0.736
<i>Primary osteoarthritis</i>	1	-	
<i>Secondary osteoarthritis</i>	19	15	
<i>Rheumatoid arthritis</i>	8	6	
<i>Fracture</i>	3	4	
<i>Metastasis</i>	-	-	
<b>Surgical approach</b>			0.529
<i>Triceps-on</i>	27	16	
<i>Triceps-flap</i>	73	9	
<i>Olecranon osteotomy</i>	1	-	
<b>Previous surgery</b>			0.339
<i>Arthroscopy</i>	4	-	
<i>Arthrotomy</i>	-	-	
<i>Fracture</i>	7	9	
<i>Ulnar nerve release</i>	2	1	
<i>Luxation</i>	-	-	
<i>External fixation</i>	-	-	
<i>Radial head surgery</i>	5	3	
<b>Comorbidities</b>			0.535
<i>ASA classification</i>			
1	3	1	
2	67	12	
3	31	12	
4	-	-	
<i>Rheumatoid arthritis</i>	10	6	0.353
<i>Diabetes</i>	2	2	0.608
<i>Smoking</i>	4	-	0.086
<i>Therapeutic anticoagulant use</i>	5	3	0.482
<b>Length of stay in days [SD]</b>	6.0 [2.5]	3.8 [2.3]	<0.001
<b>Wound leakage (days)</b>			
4	5	4	0.645
5	1	3	0.239
6	0	4	0.037
7	1	2	0.431
<b>Complications</b>			0.436
<i>Transient ulnaropathy</i>	2	2	
<i>Permanent ulnaropathy</i>	-	-	
<i>Transient radiopathy</i>	-	-	
<i>Superficial wound infection</i>	-	1	
<i>Deep prosthetic infection</i>	2	2	
<i>Fissure ulna</i>	-	-	
<i>Hematoma evacuation</i>	-	-	
<i>Triceps weakness</i>	-	-	
<i>Pneumonia</i>	2	-	
<i>30-day mortality</i>	2	-	

significantly from 6.2 to 5.4 to 3.8 days, respectively. In our opinion, this way of determining readiness for discharge gives more autonomy to the patient, which may lead to better understanding of the recovery. Strength of this study is the organization-wide implementation of the functional discharge; we made no distinction between patients and set no inclusion criteria. This approach makes the implementation of these criteria usable in other clinics as well, without increased risks.

In our center we have seen cases with elaborate blistering of the skin, presumably because of the soft tissue swelling after surgery and possibly as a reaction to non-stretching wound dressings used. However, after changing to a more skin-friendly absorbing adhesive plaster in 2016, no decline in skin blistering is observed. Of note is that patients with blistering were not more at risk for wound infections or deep prosthetic infections. We did not find an association between smoking, rheumatoid arthritis, diabetes or indication on wound complications, in contrast to other studies, presumably due to a relatively small sample size effect (6, 8, 11, 15). As the indications for TEA have shifted more towards secondary osteoarthritis instead of rheumatoid arthritis, and the triceps-on approach has been in use more recently, an indication bias might have occurred that lowered the effect of rheumatoid arthritis on wound leakage in the more recent years.

In a study on fast-track hip and knee arthroplasty, the weekday of surgery had an influence on length of stay with Friday and Thursday having a longer hospitalization, probably because of reduced staff during weekends and the tendency to discharge patients the coming Monday (4). Controversially, our study does not support these data, what further strengthens our idea of patient-discharge when possible.

As the surgical technique has shifted more towards the triceps-on technique since 2014, functional rehabilitation is possible as the triceps tendon or muscle has not been detached (3). Therefore, no restrictions on elbow extension force are necessary and more elaborate physiotherapy is possible. Of interest is that the surgical technique (triceps-on versus triceps-off) has not shown to be a confounder for length of stay, which further adds to the fast-track principle of earlier mobilization without a cast, pre-operative information and functional discharge criteria. However, the exposure during surgery with a triceps-on approach is limited compared to a triceps-flap approach. Therefore, we advise to use the approach preferred by the surgeon based on previous experience, with an own preference to the triceps-on approach.

Limitation of our study is the retrospective design, yet a randomized controlled trial seems unfeasible considering the results of this study. However, our fast-track protocol provides benefits for both patients and professionals without negative consequences. The comparison of the two institutional alterations makes interpretation of results more complicated; nevertheless, length of stay is an easy to measure, hard outcome, and the complications are dichotomous outcomes. With the use of the three subgroups the impact of the individual changes is emphasized and therefore measurable.

## CONCLUSIONS

In our cohort of 126 TEAs, omitting a cast as regular post-operative treatment reduced the length of stay significantly without leading to more complications. Introduction of functional discharge criteria lowered the length of stay further to 3.6 days without more complications. Therefore, functional discharge criteria with pre-operative information and early post-operative physiotherapy in unselected patients is possible without negative effects.

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## Corresponding author:

Ante Prkić, M.D.  
Molengracht 21  
4800 RK Breda, The Netherlands  
E-mail: aprkic@live.nl