

Fast-track rehabilitation after total knee arthroplasty reduces length of hospital stay: A prospective, case-control clinical trial

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ABSTRACT

Objectives: The aim of this study was to compare the impact of fast-track rehabilitation (FTR) and conventional rehabilitation (CR) on early recovery pattern after fast-track surgery for knee arthroplasty and conventional total knee arthroplasty (TKA).

Patients and methods: This prospective, case-control study included a total of 43 adult patients (10 males, 33 females; mean age 69 years; range, 50 to 82 years) who were clinically stable and admitted for rehabilitation after fast-track surgery for knee arthroplasty or conventional TKA January 2016 and August 2016. The patients were divided into two groups as the FTR and CR treatment groups. The FTR program was designed as a patient-focused care, early mobilization, and standardized postoperative milestones. The CR program was designed by standard postoperative rehabilitation care. Primary outcomes were the length of stay (LOS) in the hospital and knee function. Secondary outcomes were pain and activities of daily living.

Results: At baseline, both groups were similar in terms of demographic data and primary outcomes. At discharge, intra-group analysis showed significant differences in both groups in all functional outcomes, except for pain, while the inter-group LOS was also significantly different ($p < 0.001$).

Conclusion: Our study results indicate that LOS can be reduced by FTR, yielding the same results in functional recovery and autonomy as CR.

Keywords: Fast-track rehabilitation, knee, knee arthroplasty, length of stay, rehabilitation.

Conventional total knee arthroplasty (TKA) is the standard surgical treatment for management of knee joint degeneration including arthrosis, a common disease in elderly.^[1] The incidence of conventional TKA increases every year with 100 to 200 surgeries for every 100,000 individuals.^[2] In Italy in 2013, 160,000 patients underwent this surgery.^[3] The postoperative length of stay (LOS) depends on several factors: clinical conditions of the patients; traditions, cultural and personal factors;^[4] and the logistical problems of the structures.^[5,6] The mean LOS after conventional TKA is approximately 6 to 12 days; e.g. in Europe.^[3,7]

In the last decade, the concept of clinical pathways in health conditions has changed and the use of streamlined procedures and protocols has improved the quality of medical treatment, minimizing unnecessary variation in care and reducing cost including that of conventional TKA surgery.^[7] For conventional TKA surgery, it is necessary to develop fast-track approaches to reduce LOS and to improve the clinical condition at discharge, without negatively affecting clinical results or causing adverse events. Fast-track TKA protocols have been developed to decrease LOS within about two to three days. The LOS reduction can be achieved

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through the reorganization of the Orthopedic surgery units, or with patients who have specific characteristics such as age, co-morbidities, and clinical stability.^[4-6] In a study conducted in Denmark, the fast-track TKA programs used after conventional TKA decreased LOS by 60%.^[8] After fast-track TKA, recovery patients are usually transferred to rehabilitation units to undergo fast-track rehabilitation (FTR),^[9] obtaining a faster recovery of joint function.^[10] This period usually takes between two and three weeks,^[11] with various rehabilitation programs depending on the patient condition and daily treatment time. The growing number of patients treated with fast-track TKA has prompted the planning of FTR programs with precise tasks and defined times.^[4] The goal of this rehabilitation program is to discharge the patient eight days after admission to the rehabilitation unit and without any clinical complications,^[12] instead of the usual two or three weeks normally employed. Evaluation of function and quality of life for patients treated with FTR and with a conventional rehabilitation (CR)^[13] is useful to determine how FTR may influence the outcome of the patient.^[14] Previous studies focused on the postoperative rehabilitation; e.g., the first and second day after surgery, but the rehabilitation after this period is for our knowledge never been studied in deep.

In the present study, we aimed to investigate FTR and its ability to enhance joint knee function recovery and reduce LOS compared to CR.

PATIENTS AND METHODS

This prospective, case-control study was conducted in a single orthopedic surgical ward center in a post-acute rehabilitation hospital of Northern Italy between January 2016 and August 2016. All patients were recruited on the second day after surgery. Inclusion criteria were as follows: aged >18 years; both sexes; and being admitted for elective rehabilitation after conventional TKA or fast-track TKA with a clinical stability (hemoglobin >9 g/L). Exclusion criteria were as follows: presence of rheumatoid arthritis; previous orthopedic surgery of the lower limb; malignancies; neurological and psychiatric diseases with an inability to understand; clinical evaluation of dementia (Mini-Mental Test score <24); and participation in other clinical studies. Based on previous studies, an additional exclusion criterion was the presence of pain measured with a Numerical Rating Scale (NRS) score of >4, as it has been demonstrated that pain has a limited role in functional recovery in

the early postoperative period and the intensity is usually very low (NRS score <4) at discharge from orthopedic surgical center after both surgeries.^[15,16] Saturation was measured through an optical pulse oximeter (Prontex Pulse O₂, Bovisio masciago, Italy) at subjects' finger. A total of 50 patients were admitted to the post-acute rehabilitation hospital after discharge and seven patients were excluded due to other medical conditions. Finally, while a total of 43 adult patients (10 males, 33 females; mean age 69 years; range, 50 to 82) were included. The patients were divided into two groups based on the type of surgery (fast-track TKA or conventional TKA). The fast-track group (FTG) consisted of 20 patients who participated in the FTR program and the conventional group (CG) consisted of 23 patients who underwent the CR program (Figure 1). Demographic and clinical data of each patient were collected at the time of admission (T0). A written informed consent was obtained from each patient. The study protocol was approved by the Fondazione Don Gnocchi Ethics Committee (No. 4-16/12/2015) and registered on Clinicaltrial.gov (NCT03035435). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Surgery

Fast-track TKA was performed through a sub-vastus approach, and a patella-in-place balancer was used. All patients received intraoperative local infiltration analgesia and received a patella component.

Conventional TKA was performed through a midline approach and all patients received a patella component. The patients also received patient-controlled analgesia with intravenous morphine, wound drains, and bladder catheters.

Outcomes

Primary outcomes were LOS and knee joint mobility evaluated with the International Knee Society System (IKSS) scores. Secondary outcomes were pain intensity and activities of daily living (ADL), respectively measured with the NRS and Modified Barthel Index (MBI).^[17] All patients were evaluated with reliable and validated scales specific for joint knee function, pain intensity, and ADL. The LOS was evaluated by counting the number of postoperative nights in the rehabilitation center until discharge.

The IKSS is a validated scale to measure clinical outcomes of rehabilitation and focuses on range of motion, pain, stability of the knee, walking, and ascent

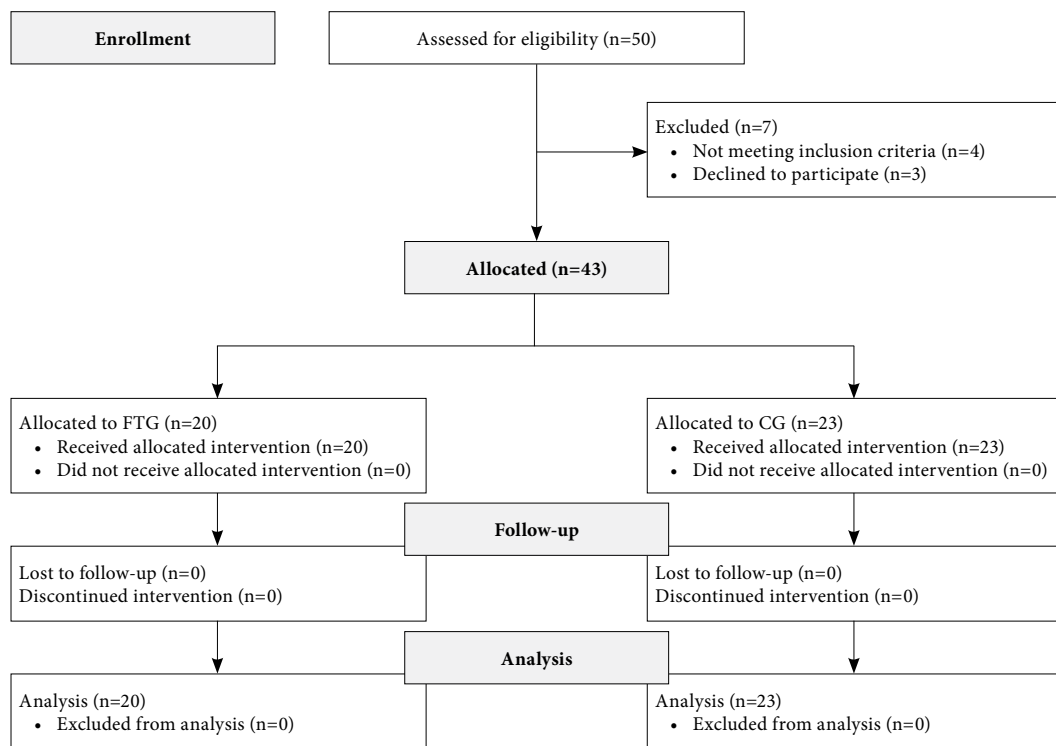


Figure 1. Study flowchart.

FTG: Fast-track group; CG: Conventional group.

and descent of the stairs.^[18,19] The NRS is a validated scale to measure the intensity of pain, with numbers between zero and 10, with zero representing absence of pain and 10 the worst possible pain experienced by the patient.^[20] The MBI is a validated scale to evaluate independence in the ADL and disability of the patient, and to demonstrate improvements during the recovery.^[21]

For both groups, discharge occurred after a physician decision based on clinical expertise, independence in ADL, transfers, walking ability (>250 m), no pain, and good knee function.^[4]

Interventions

The reporting of interventions is based on the Template for Intervention Description and Replication (TIDieR) checklist,^[22] which includes 12 items ranging from intervention name to adherence and fidelity, as reported below.

Fast track rehabilitation protocol

The FTR protocol was characterized by patient-focused care and early mobilization with standardized postoperative milestones. The patients received a specific program including getting up on the day of the surgery, climbing stairs two days after surgery, and

standard intensive physiotherapy with a focus on ADL in a living room and individual case management. The main clinical aims were to increase the recovery of the knee with passive and active mobilization of the joint knee through a Kinetec® (Chinesport, Italy) tool, twice a day, recovery and improvement of strength of the physiological extension of lower limb muscular groups (i.e., quadriceps and knee flexors) through physical exercise, and the proprioception of the affected limb. Autonomy was improved through teaching the postural transitions and the gait with crutches from the first day post-surgery, learning how to climb and descend the stairs in the second day post-surgery, and recovering autonomy during ADL.

The program was provided by full time physiotherapists with a specific expertise per protocol for a total of eight sessions. Each session was 60 min in duration and sessions occurred every day for during the hospital stay. Sessions were performed individually in the rehabilitation hospital and all patients remained adhered to treatment.

Conventional rehabilitation protocol

The CR program was characterized by standard postoperative care per protocol on an individual care basis, according to patient's subjective demands.

It included an intravenous fluid program for the first 24 h after surgery. First mobilization on the second day after surgery, and daily physiotherapy in single exercises: walking exercises, passive flexion-extension of the knee up to 90°, strengthening of the lower limb muscles, and respiratory training. The types of exercise used were similar for both interventions, with differences mainly at the beginning of treatment during admission and exercises during physiotherapy sessions. The program was provided by full time physiotherapists for a total of 15 sessions. Each session was 60 min in duration and sessions occurred every day for the entire hospital stay period. Sessions were performed individually in the orthopedics department of the hospital and all patients remained adhered to treatment. Both programs were changed or stopped in case of adverse effects.

Statistical analysis

The power analysis and sample size calculation were performed using the G*Power version 3.1.3.2 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). The sample size was calculated based on the literature, considering the primary outcome. A total of 40% faster improvement of LOS during the time of recovery was considered as significantly relevant (effect size according to Cohen was "large" ($d=0.8$).^[4] With an alpha set to 0.05 and a power of 80%, we calculated that 45 patients were required for the study. Considering 10% drop-out rate, a total of 50 patients were recruited based on a 1:1 distribution for the study.

Statistical analysis was performed using the PASW version 17.0 software (SPSS Inc., Chicago, IL, USA). The study was reported following the indications of the STROBE statement. Descriptive data were expressed in mean \pm standard deviation (SD), median (min-max) or number and frequency. Preliminary analyses demonstrated significant violations of parametric test assumptions (e.g. normality distribution when tested with the Shapiro-Wilk test). Considering that violations of parametric test assumptions might lead to relevant distortions in the results, we decided to use non-parametric tests with exact p-value calculation in our analyses. The non-parametric Mann-Whitney U test was used to investigate potential between-group differences in continuous variables of demographic characteristics and outcome scores, while the Fisher's exact test was employed for gender distribution. The Wilcoxon test was used to investigate within-group differences in all outcome scores during the recovery. Since the participants completed the study without any major protocol violations, per protocol analysis was used. Due to the difference in sample size between groups, we considered a confidence interval (95%) to evaluate the power of the observed treatment effect on LOS from the data collected in relation to the minimum clinically relevant difference.^[23] A p value of <0.05 was considered statistically significant.

RESULTS

Baseline demographic and clinical characteristics of the patients are shown in Table 1. At baseline (T0),

TABLE 1
Demographic and clinical characteristics of patients

Characteristics	Fast-track Group (n=20)				Control Group (n=23)				p
	n	%	Median	25 th -75 th percentile	n	%	Median	25 th -75 th percentile	
Age (year)			69	60-77			69	65-73	0.791*
Sex	14	70.0			19	83.3			0.472**
Female									
Height (cm)			164	160-168			162	160-168	0.984*
Weight (kg)			78.0	69.0-80.0			80.0	75.0-83.5	0.154*
Body mass index (kg/m ²)			27.7	25.4-29.4			29.4	26.2-32.5	0.079*
Saturation (%SpO ₂)			97.0	96.0-97.3			97.0	96.0-98.0	0.827*
Hemoglobine (g/dL)			11.5	10.6-12.4			10.2	9.8-10.8	<0.001*
Modified Barthel Index (0-100)			76.0	70.0-76.5			71.0	63.0-76.0	0.059*
NRS (0-10)			0.0	0.0-1.0			0.0	0.0-0.0	0.880*
IKSS Score (0-200)			73.0	65.0-82.5			68.0	57.5-73.0	0.256*

NRS: Numerical Rating Scale; IKSS: International Knee Society System; * Mann-Whitney test; statistical significance at $p<0.05$; ** Fisher's exact test.

TABLE 2
Within-group differences in FTR and CR groups

	Fast-track Group (n=20)				p§	Control Group (n=23)				p§
	T0		T1			T0		T1		
	Median	25 th -75 th percentile	Median	25 th -75 th percentile		Median	25 th -75 th percentile	Median	25 th -75 th percentile	
Modified Barthel Index (0-100)	76.0	70.0-76.5	100.0	90.0-100.0	<0.001*	71.0	63.0-76.0	100.0	95.0-100.0	<0.001*
NRS (0-10)	0.0	0.0-1.0	0.0	0.0-0.0	0.045*	0.0	0.0-0.0	0.0	0.0-0.0	0.078**
IKSS Score (0-200)	73.0	65.0-82.5	114.5	113.0-125.0	<0.001*	68.0	57.5-73.0	113.0	113.0-124.0	<0.001*

FTR: Fast-track rehabilitation; CR: Conventional rehabilitation; NRS: Numerical Rating Scale; IKSS: International Knee Society System; § Within-group analysis; * Wilcoxon Test; statistical significance at p<0.05.

patients showed homogeneous clinical conditions (p>0.05). At discharge (T1), both groups showed a significant improvement in all functional outcomes, MBI and IKSS (p<0.001). Only the FTG group showed a significant decrease of pain symptom in NRS score (p<0.05) (Table 2). Between-group analysis showed a significant difference in LOS (p<0.001) (Figure 2). The mean LOS was 10.6±3.2 days in the FTG and 17.3±3.8 days in the CG (Table 3).

DISCUSSION

This study is a novel approach in its attempts to evaluate the effects of FTR on the recovery pattern of patients who were admitted to a rehabilitation hospital for fast-track TKA. Our hypothesis was that FTR would result in reduction in LOS compared to CR. The main finding was that FTR reduced LOS by a mean of 6.71 days, achieving a significant improvement in the joint knee functional recovery and autonomy. Patients with fast-track TKA were admitted to the rehabilitation center with a better knee joint mobility

than patients with conventional TKA (mean IKSS score: 73.3±13.3 vs. 68.5±13.7, respectively), although this difference was not statistically significant. These findings are supported by the literature, in which FKTA patients have a functional recovery in the early postoperative period (two or three days).^[16]

The current study results fill a gap in fast-track TKA patient management after orthopedic surgical ward discharge. During the last decade, the interest in optimal multimodal perioperative care has increased to enhance recovery (the fast-track methodology). Improvement of preoperative treatments analgesia, reduction of surgical stress responses and organ dysfunctions including nausea, vomiting, and ileus, early mobilization, and oral nutrition were applied to fast-track TKA. This has led to reduced pain and facilitated early mobilization, allowing functional rehabilitation to be initiated a few hours postoperatively.^[5,24] Patients were, thus, able to reach the rehabilitation hospital with better knee functional recovery and start FTR on the day of admission.^[25] In addition, a previous study showed a significant reduction of LOS with improvement of functional recovery of knee during postoperative fast-track TKA,^[9] but focusing only on the postoperative rehabilitation (within two days of surgery). This data

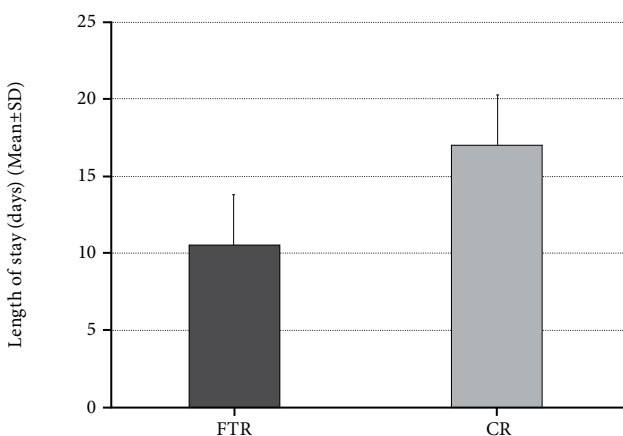


Figure 2. Length of stay.

FTR: Fast-track Rehabilitation; CR: Conventional rehabilitation; SD: Standard deviation.

TABLE 3
Length of stay at discharge (day)

	n	Mean±SD	95% CI
Fast-track	20	10.6±3.2	9.06 to 12.04
Control	23	17.3±3.8	15.60 to 18.92
Mean difference		-6.7±1.1	-8.87 to -4.55
P value§		<0.001*	

SD: Standard deviation; CI: Confidence interval; § Between-group differences; * Mann-Whitney test; Alpha level is set at 0.05.

supports our results and increase their importance: early rehabilitation has a sustainable effect on the functional recovery of knee and a reduction of LOS^[12] and can decrease the LOS also in the rehabilitation ward, not only in the orthopedic ward, consistent with our study. Husted et al.^[26] reported that patients could be discharged within three days of surgery, although this time might be reduced to one or two days by the improvement of perioperative analgesia, reduction of the risk of orthostatic hypotension, improvement of quadriceps muscle function, and avoidance of logistical problems hindering early discharge. This may also improve functional recovery and accelerate patient inclusion into FTR programs, reducing LOS.

The main limitations of the present study included its logistic issues during the recruitment and data collection which prohibited recruitment of an adequate sample size. Despite these issues, our data is valuable as it shows that fast-track TKA allows to the patients to be admitted to the rehabilitation hospital with better knee joint mobility and to start FTR on their first day, obtaining a significant improvement of knee functional recovery and autonomy within six days of admission.

In conclusion, patients undergoing fast-track TKA have a shorter LOS in the orthopedic surgical center and in a post-acute rehabilitation hospital and FTR can reduce the time of knee functional recovery in this population. Nonetheless, further studies evaluating the quality of life and patient satisfaction according to the type of surgical protocol are needed.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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REFERENCES

- Grayson CW, Decker RC. Total joint arthroplasty for persons with osteoarthritis. *PM R* 2012;4(5 Suppl):S97-103.
- Singh JA, Vessely MB, Harmsen WS, Schleck CD, Melton LJ 3rd, Kurland RL, et al. A population-based study of trends in the use of total hip and total knee arthroplasty, 1969-2008. *Mayo Clin Proc* 2010;85:898-904.
- Torre M, Romanini E. The Italian ArthroPlasty Registry: a model to export?. *Recenti Prog Med* 2016;107:218-24.
- den Hertog A, Gliesche K, Timm J, Mühlbauer B, Zebrowski S. Pathway-controlled fast-track rehabilitation after total knee arthroplasty: a randomized prospective clinical study evaluating the recovery pattern, drug consumption, and length of stay. *Arch Orthop Trauma Surg* 2012;132:1153-63.
- Husted H, Holm G, Jacobsen S. Predictors of length of stay and patient satisfaction after hip and knee replacement surgery: fast-track experience in 712 patients. *Acta Orthop* 2008;79:168-73.
- Yasunaga H, Tsuchiya K, Matsuyama Y, Ohe K. Analysis of factors affecting operating time, postoperative complications, and length of stay for total knee arthroplasty: nationwide web-based survey. *J Orthop Sci* 2009;14:10-6.
- Petersen MK, Andersen NT, Søballe K. Self-reported functional outcome after primary total hip replacement treated with two different perioperative regimes: a follow-up study involving 61 patients. *Acta Orthop* 2008;79:160-7.
- Husted H, Jensen CM, Solgaard S, Kehlet H. Reduced length of stay following hip and knee arthroplasty in Denmark 2000-2009: from research to implementation. *Arch Orthop Trauma Surg* 2012;132:101-4.
- Larsen K, Hansen TB, Søballe K, Kehlet H. Patient-reported outcome after fast-track knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2012;20:1128-35.
- Khan F, Ng L, Gonzalez S, Hale T, Turner-Stokes L. Multidisciplinary rehabilitation programmes following joint replacement at the hip and knee in chronic arthropathy. *Cochrane Database Syst Rev* 2008;(2):CD004957.
- Benz T, Angst F, Oesch P, Hilfiker R, Lehmann S, Mueller Mebes C, et al. Comparison of patients in three different rehabilitation settings after knee or hip arthroplasty: a natural observational, prospective study. *BMC Musculoskelet Disord* 2015;16:317.
- Husted H, Lunn TH, Troelsen A, Gaarn-Larsen L, Kristensen BB, Kehlet H. Why still in hospital after fast-track hip and knee arthroplasty? *Acta Orthop* 2011;82:679-84.
- Villafañe JH, Isgro M, Borsatti M, Berjano P, Piralì C, Negrini S. Effects of action observation treatment in recovery after total knee replacement: a prospective clinical trial. *Clin Rehabil* 2017;31:361-8.
- Barbieri A, Vanhaecht K, Van Herck P, Sermeus W, Faggiano F, Marchisio S, et al. Effects of clinical pathways in the joint replacement: a meta-analysis. *BMC Med* 2009;7:32.
- Winther SB, Foss OA, Wik TS, Davis SP, Engdal M, Jessen V, et al. 1-year follow-up of 920 hip and knee arthroplasty patients after implementing fast-track. *Acta Orthop* 2015;86:78-85.
- Holm B, Kristensen MT, Myhrmann L, Husted H, Andersen LØ, Kristensen B, et al. The role of pain for early rehabilitation in fast track total knee arthroplasty. *Disabil Rehabil* 2010;32:300-6.
- de Morton NA, Keating JL, Davidson M. Rasch analysis of the barthel index in the assessment of hospitalized older patients after admission for an acute medical condition. *Arch Phys Med Rehabil* 2008;89:641-7.
- Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. *Clin Orthop Relat Res* 1989;248:13-4.
- The Knee Society Score [Internet]. The Knee Society. Available at: <http://kneesociety.org/the-knee-society-score/> [Accessed: May 27, 2020].

20. Sloman R, Wruble AW, Rosen G, Rom M. Determination of clinically meaningful levels of pain reduction in patients experiencing acute postoperative pain. *Pain Manag Nurs* 2006;7:153-8.
21. Castiglia SF, Galeoto G, Lauta A, Palumbo A, Tirinelli F, Viselli F, et al. The culturally adapted Italian version of the Barthel Index (IcaBI): assessment of structural validity, inter-rater reliability and responsiveness to clinically relevant improvements in patients admitted to inpatient rehabilitation centers. *Funct Neurol* 2017;22:221-8.
22. Negrini S. Application of the TIDieR checklist to improve understanding and replicability of studies in Physical and Rehabilitation Medicine. *Eur J Phys Rehabil Med* 2015;51:667-8.
23. Walters SJ. Consultants' forum: should post hoc sample size calculations be done? *Pharm Stat* 2009;8:163-9.
24. Holm B, Kristensen MT, Bencke J, Husted H, Kehlet H, Bandholm T. Loss of knee-extension strength is related to knee swelling after total knee arthroplasty. *Arch Phys Med Rehabil* 2010;91:1770-6.
25. Schneider M, Kawahara I, Ballantyne G, McAuley C, Macgregor K, Garvie R, et al. Predictive factors influencing fast track rehabilitation following primary total hip and knee arthroplasty. *Arch Orthop Trauma Surg* 2009;129:1585-91.
26. Husted H, Lunn TH, Troelsen A, Gaarn-Larsen L, Kristensen BB, Kehlet H. Why still in hospital after fast-track hip and knee arthroplasty? *Acta Orthop* 2011;82:679-84.