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Assessment of Recovery Patterns After Common Orthopaedic Surgical Procedures

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Abstract — Recovery from orthopaedic surgery can take various paths related to pain relief, physical ability, and functional independence. This paper proposes a prospective observational scheme for evaluating recovery after total knee arthroplasty, total hip arthroplasty, and open reduction and internal fixation of ankle fractures. The hypothetical sample size consists of 180 individuals with 60 subjects per group. Post-operative pain is evaluated on day three post-operation and at weeks two, six, and twelve, and lower limb function is evaluated using the Lower Extremity Functional Scale at weeks two, six, and twelve. The mean pain drops from 6.80 to 2.30 after knee arthroplasty, from 6.30 to 1.70 after hip arthroplasty, and from 6.50 to 2.10 after ankle fixation. The mean increase in function between weeks two and twelve is 24, 29, and 27, respectively. The difference in functional recovery between groups is statistically significant, and there is no such difference in pain recovery. The ability to walk independently without the use of any devices occurs in 70.0%, 81.7%, and 58.3% of the groups at twelve weeks. Such a hypothetical course of recovery demonstrates consistency in reporting. The real interpretation should include adjustments for the initial state, experience in rehabilitation, and specifics of the procedure.

Keywords —Orthopaedic surgery, postoperative recovery, rehabilitation, pain, lower extremity function, functional independence

Introduction

The primary goals of orthopaedic surgery are pain relief, restoration of function, and improving participation in activities of daily living. But a good operation does not lead

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to the same or quick recovery. Pain may be relieved before regaining muscle strength, while confidence and independence in walking will be restored much later. Thus, assessment should involve multiple outcomes measured at different points in time rather than one postoperative score.

Total knee arthroplasty, total hip arthroplasty, and ankle-fracture fixation are very different procedures. Joint arthroplasty is aimed at addressing joint diseases while ankle fixation is used for treating an acute injury. Therefore, patients of these procedures will differ considerably in age, mobility prior to surgery, medical conditions, rehabilitation needs and other factors. Comparisons require consideration of these aspects.

Kennedy et al. have shown the importance of modelling repeated postoperative scores and using both patient-reported outcome measures and physical performance test scores [1]. Naylor et al. performed similar evaluation of recovery from knee and hip replacement in relation to physical and patient-centred outcomes [2]. These works suggest that recovery should be considered as a changing multidimensional phenomenon.

Enhanced perioperative pathways also play their role in recovery nowadays. Enhanced recovery programmes combine preparation for surgery, pain relief, early mobilization, and discharge planning [3]. After fracture fixation, recovery is additionally affected by injury characteristics and load restrictions.

This paper proposes a reporting scheme for the first 12 weeks after surgery. It involves common tools for evaluating pain and lower limb function while preserving the specifics of each procedure.

Literature review

Longitudinal nature of recovery process

Kennedy et al. [1] studied early functional recovery following knee or hip arthroplasty using physical and self-report assessments. This study underlines the necessity to use repeated measurements since the shape of recovery cannot be fully described by the endpoint alone.

Naylor et al. [2] compared recovery following knee and hip replacement across various dimensions. These findings indicate that improvement in symptoms should be differentiated from the improvement in performance. There is a possibility of improvement in patients' perception of the benefit while they are still limited in walking, transferring and endurance.

Another study by Kennedy et al. [4] studied preoperative function and other predictors of postoperative recovery. This study reinforces the necessity to consider the baseline status. Better postoperative score might partly reflect the better initial status rather than the actual improvement.

Perioperative care and rehabilitation

Wainwright et al. [3] elaborated ERAS Society recommendations for hip and knee replacement. The consensus covers various aspects of perioperative care, including the necessity to document the rehabilitation processes rather than treating rehabilitation as a homogeneous exposure.

Kehlet and Thienpont [5] considered the fast track knee arthroplasty and challenges to it. This publication is important since reduced hospital stay does not imply full functional

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recovery. Hospital discharge and subsequent independence are related but different outcomes.



Guidance of NICE on primary joint replacement [6] covers preparation, rehabilitation and support along the care pathway. This guidance provides institutional framework for documenting the processes of rehabilitation while tailoring care to individual needs. It does not provide a universal recovery timeline which could apply to all patients.

Recovery after ankle fracture fixation

Dehghan et al. [7] compared early weight-bearing and range-of-motion exercises with non-weight-bearing and immobilization after ankle fracture fixation. The trial proves the influence of postoperative rehabilitation on early outcomes and the necessity to document it during recovery interpretation.

The multicentre trial of WAX conducted by Bretherton et al. [8] compared early and delayed weight-bearing after surgically treated ankle fracture. These findings justify the need for further research on early loading in carefully selected patients. However, the results of trials do not allow to adopt the same loading protocol for all fractures, all fixation and all patients.

The above studies show why walking milestones are hard to interpret without knowledge about restrictions adopted by the treating team. A patient uses crutches because of loading restriction, despite pain and confidence improvement.

Measurement of function and mobility

Binkley et al. [9] developed the Lower Extremity Functional Scale (LEFS). It is the patient report questionnaire measuring activity limitation due to the musculoskeletal condition in lower limb. Due to the common scoring structure, it allows to conduct descriptive assessment of recovery across the selected procedures. Although the scores should be considered in the clinical context.

Podsiadlo and Richardson [10] developed the Timed Up and Go test which serves as a measure of basic functional mobility in frail older adults. It illustrates the complementary value of the performance testing. At the same time, it is important to consider safety issues, walking aids and loading restrictions when applying such test to various surgical patients.

Pain persistence and incomplete recovery

Beswick et al. [11] conducted systematic review of prospective studies on long-term pain after hip and knee replacement. This study proves that positive mean outcomes are possible together with individual problems.

Wylde et al. [12] considered chronic pain after knee arthroplasty and its assessment. This research also proves the necessity to report distribution of outcomes and individual problems instead of mean outcomes decline. Twelve-week

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improvement does not prove a satisfactory long-term outcome.

Research gap

The practical gap considered in the current paper consists in the necessity to conduct the same follow-up measures across selected lower-limb procedures, while maintaining difference in indications, patient characteristics and rehabilitation restrictions. The common framework can help with service evaluation, but comparisons should remain descriptive without proper adjustment.

Objectives

The first objective is to compare changes in function of lower limbs between two and twelve weeks after the selected procedures.

Secondary objectives are to describe pain trajectories, compare walking independence at twelve weeks and identify contextual variables which should be considered during recovery interpretation.

Hypotheses

The first null hypothesis is that mean LEFS change between weeks two and twelve does not differ among groups of procedures.

Secondary null hypotheses are that mean pain change and the proportion walking independently without an aid at twelve weeks do not differ among the groups.

Materials and Methods

Design and Population

A prospective observational cohort design is suggested to be used in an orthopaedic service. Adults will receive either unilateral primary total knee arthroplasty, unilateral primary total hip arthroplasty, or ankle-fracture open reduction and internal fixation.

Consecutive eligible subjects will be recruited in each procedure category. Subjects undergoing revision surgery, bilateral procedures, pathological fractures, major associated injuries, and any conditions which would preclude meaningful questionnaire completion will be excluded from this specific assessment.

The simulation sample for analysis is made up of 60 patients' cases for each procedure. Equal groups will be made for this simulation exercise and do not reflect the true frequency of procedures in hospitals.

Clinical and Rehabilitation Environment

Arthroplasty subjects will undergo surgery due to degenerative joint disease. Ankle subjects will have an isolated fracture requiring fixation. Surgical specifics, other medical problems, postoperative complications, rehabilitation attendance, and patient weight-bearing will be documented.

Treatment will be managed by the clinical team. There will be no common loading regime in the study across procedures.

Assessment schedule

Table A. Proposed postoperative assessment schedule

Measure	Day three	Week two	Week six	Week twelve

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Average operated-limb pain	Yes	Yes	Yes	Yes
LEFS	—	Yes	Yes	Yes
Walking aid and assistance	Yes	Yes	Yes	Yes
Weight-bearing prescription	Yes	Yes	Yes	Yes
Rehabilitation exposure	Initial plan	Yes	Yes	Yes
Complications and medication	Yes	Yes	Yes	Yes

The follow-up periods would be predetermined, like ±3 days for week 2 and ±7 days for weeks 6 and 12. The actual dates of evaluation would be kept for further analysis.

Pain evaluation

Participants would provide their rating of the average pain experienced by the operated limb over the past 24 hours, using a numeric rating scale ranging from zero (no pain) to ten (worst pain).



Time of medication and time of activity would be recorded as both can affect the rating scores. Change in pain would be measured by subtracting the day three score from the twelve-week score, negative score would denote improvement in pain.

Day three represents an early postoperative reference point and not preoperative one.

Functional Assessment

LEFS includes 20 questions and generates a score ranging from 0 to 80, where high score denotes good function [9]. Outcome measure would be twelve-week minus two-week LEFS score.

Language validated version of the instrument would be used if exists. It will be administered according to the instrument instructions. Patients' restriction in activity would be considered along with precaution advised by the physician rather than biological disability only.

Walking Independence

Walking independence would mean walking a 20 metres straight course indoors under supervision without any physical support or use of any assistive device.

Patients using assistive device, needing help for walking or being forbidden to perform the test would not qualify the criteria. Reason would be recorded separately in actual study. Not meeting the criteria does not necessarily denote delayed recovery.

Sample-size Calculation

Given 60 observations per group, comparison between two independent groups with a standard deviation of 11 for the

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functional score change would have around 80% power to detect a 5.6 point difference at a 5% level of significance.

This calculation is used as a basis for sample size calculation but not formal justification of a three-group power analysis. An appropriate protocol should calculate the sample size based on the planned analysis.

Statistical Analysis

Continuous data are summarized in terms of means and standard deviations. Difference between change scores is assessed by one-way analysis of variance for three groups. Pearson's chi-square test for walking independence.



Intermediate measures outline trajectories. A repeated-measures regression is not estimated since the covariances between observations at the individual level are unknown. Secondary analyses are exploratory, and p-values are not adjusted for multiple testing.

All the described statistics are computed from the summary values simulated. The effects of adjusted procedures, patient-level trajectories, mechanisms of missing data, and model diagnostics cannot be verified.

Ethics

In real recruitment, ethics clearance and patient consent are necessary. Treatment and prevention will be prioritized over evaluation. Ethics clearance number or consent procedure are not claimed in the draft.

Results

Participant profile

The simulated analytical sample consists of 180 patients.

Table B. Simulated participant characteristics

Characteristic	Knee arthroplasty, n=60	Hip arthroplasty, n=60	Ankle fixation, n=60
Age, years	66.2 ± 7.4	62.8 ± 9.1	43.6 ± 12.8
Women, n (%)	36 (60.0)	32 (53.3)	28 (46.7)
Body mass index, kg/m²	28.7 ± 4.2	27.4 ± 4.0	26.1 ± 4.5

The ankle group is younger, illustrating an important source of confounding in unadjusted comparisons.

Pain trajectories

Table C. Simulated pain scores across follow-up

Time point	Knee arthroplasty	Hip arthroplasty	Ankle fixation
Postoperative day three	6.80 ± 1.30	6.30 ± 1.40	6.50 ± 1.50

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Week two	5.10 ± 1.40	4.20 ± 1.50	4.80 ± 1.60
Week six	3.40 ± 1.50	2.50 ± 1.40	3.20 ± 1.50
Week twelve	2.30 ± 1.40	1.70 ± 1.30	2.10 ± 1.40
Change: week twelve minus day three	−4.50 ± 1.40	−4.60 ± 1.50	−4.40 ± 1.60

Values are mean ± standard deviation.

Mean pain decreases in every group. The between-group comparison of change is not statistically significant, \(F(2,177) = 0.27\),\(p = 0.767\). This does not establish equivalence.

Functional recovery

Table D. Simulated LEFS scores and changes

Assessment	Knee arthroplasty	Hip arthroplasty	Ankle fixation
Week two	27.0 ± 9.0	31.0 ± 10.0	20.0 ± 8.0
Week six	41.0 ± 11.0	48.0 ± 12.0	34.0 ± 11.0
Week twelve	51.0 ± 12.0	60.0 ± 11.0	47.0 ± 13.0
Change: week twelve minus week two	24.0 ± 10.0	29.0 ± 11.0	27.0 ± 12.0

Statistically significant is the comparison of the functional change, \(F(2,177)=3.12\),\(p=0.046\). This omnibus result simply tells us that there is a difference somewhere between the means. However, this does not imply that all pairs of means are different.

Walking independence

Table E. Simulated walking milestone at twelve weeks

Status	Knee arthroplasty	Hip arthroplasty	Ankle fixation
Independent without an aid	42	49	35
Milestone not met	18	11	25
Total	60	60	60
Milestone attained	70.0%	81.7%	58.3%

Generally speaking, 126 of 180 patients, that is 70.0%, reach the milestone. The test for group comparison results in \(\chi^2(2)=7.78\), \(p=0.020\).

Rates of complications and rehospitalizations are not reported due to the lack of observations concerning clinical events.

Discussion

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Patterns of simulated values indicate a general increase in pain relief and function in all three interventions with different absolute values of functional improvement and walking ability. These distinctions prove the necessity of different approaches to achieving recovery.

Pain relief is generally equal regardless of distinct twelve-week levels of pain. The point here is that the final scores and the scores of changes measure different things. In some cases, the lower final score is explained by the lower initial value of pain.

There are minor differences between levels of functional improvement but their interpretation is restricted due to the heterogeneity of the sample and intervention types. The youngest ankle group starts with the lowest two-week LEFS score which indicates acute trauma and restrictions of loading.

This result corresponds to longitudinal studies of multidimensional recovery and the importance of patients' initial conditions [1,2,4]. Nevertheless, the similarity to the patterns in scientific literature does not justify the simulated values.

Walking independence provides additional information but it depends on the set restrictions. Trials on ankle rehabilitation [7,8] explain the necessity to report on the strategy of loading.

Assessment of the exposure to rehabilitation is required. The number of rehabilitation sessions can be interpreted as a measure of access, patients' motivation and severity of the condition, clinical needs. Therefore, a relationship between the number of rehabilitation sessions and outcomes would not prove the effect of the treatment.

Twelve weeks is not enough to judge about long-lasting pain, return to work and sports activity or long-term participation. Reviews of pain after arthroplasty [11,12] prove that the favourable average values hide the individual problems with pain. Therefore, further follow-up is necessary to explore the unresolved symptoms and the preferences of patients.

The clinically meaningful reporting includes group summary, individual trajectories, reasons of failure to achieve the milestone and complications. It is impossible to introduce one universal definition of full recovery in the context of all three procedures.



Limitations

All results obtained are simulated and do not give any empirical information about a hospital and its patients.

Proposed observational design is subject to confounding by indication, age, comorbidity, and rehabilitation limitations. Complete-case analysis may mask worse results from those participants who lack follow-up.

Standardized questionnaires increase validity of results but do not allow equalizing of procedure groups. Absence of data on

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individual participants makes adjustments impossible. Twelve weeks is not enough time for achieving complete recovery or surgical success.

Conclusion

Recovery following standard orthopaedic procedures of lower limb needs to be assessed by regular measures of pain, function and mobility. Simulated tables serve as a framework for consistent reporting and show that pain relief and ability to function independently may have different dynamics. Actual conclusions can be drawn only on the basis of empirical data and adequate adjustments.

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