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ORTHOPAEDIC OUTCOME ASSESSMENT

Readmissions after fast-track hip and knee arthroplasty

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Abstract
Introduction With the implementation of fast-track surgery with optimization of both logistical and clinical features, the postoperative convalescence has been reduced as functional milestones have been achieved earlier and consequently length of stay (LOS) in hospital has been reduced. However, it has been speculated that a decrease in LOS may be associated with an increase in readmissions in general, including risk of dislocation after total hip arthroplasty (THA) or manipulation after total knee arthroplasty (TKA).
Materials and methods 1,731 consecutive, unselected patients were operated with primary THA or TKA in a well-described standardized fast-track setup from 2004 to 2008. All readmissions and deaths within 90 days were analyzed using the national health register.
Results Mean LOS decreased from 6.3 to 3.1 days. Within 90 days, 15.6% of patients following TKA were readmitted as opposed to 10.9% after THA ($p = 0.005$). Three deaths (0.17%) were associated with clotting episodes. Suspicion of DVT (not found) and suspicion of infection made up half of the readmissions. Readmissions in general and for thromboembolic events, dislocations and manipulations in specific did not increase with decreasing LOS. There was no difference between readmission rates per year for either TKA or THA but there was a significantly reduced risk of dislocation found with decreasing LOS comparing each year from 2005 to 2007 with the index year of 2004 (with the longest LOS and the highest incidence of dislocation).
Conclusion Fast-track TKA and THA do not increase the readmission rate. Readmissions are more frequent after TKA than THA, but dislocation after THA and manipulation after TKA do not increase as LOS is decreasing.

Keywords Fast-track · Total hip arthroplasty · Total knee arthroplasty · Readmissions · Dislocation · Manipulation

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Introduction

Total hip and knee arthroplasty (THA and TKA) effectively reduce pain, restore or improve joint mobility and improve gait. However, pre- and postoperative risks are associated with these operations potentially leading to readmissions necessitating additional medical or surgical procedures.

With the implementation of fast-track surgery with optimization of both logistical and clinical features, the postoperative convalescence has been reduced as functional milestones have been achieved earlier and consequently length of stay (LOS) in hospital has been reduced [1]. However, it has been speculated that a decrease in LOS may be associated with an increase in readmissions in general,

including risk of dislocation after THA [2] or manipulation after TKA [3, 4]. We therefore, report a consecutive series of primary THA and TKA in a fast-track setup with early mobilization and short hospitalization with specified 90-day readmission rates, including death and where LOS has been decreasing over time from about 6 to 3 days.

Materials and methods

The fast-track setup consists of optimized logistical and evidence-based clinical features [5] and was implemented in 2003. Since then, all the patients operated with THA, TKA, bilateral simultaneous TKA, and bilateral simultaneous THA have been enrolled in the programme. Focus has been on pain treatment and early mobilization and ongoing research refines these tools of improving convalescence and subsequently reducing LOS. Hence, LOS has been reduced in increments: from 2004 to 2006 the intended LOS was approximately 5 days and from 2007 to 2008 the intended LOS was 3 days—as local infiltration analgesia (LIA) was introduced allowing patients to be mobilized with only moderate pain [6, 7].

All patients are consecutive and unselected and were operated on using epidural anesthetic—from 2004 to 2006, epidural for TKAs and spinal anesthesia for THAs were used, but from 2007, spinal anesthesia with 2 mL hyperbaric bupivacaine 0.5% (TKA) or 2.5 mL plain bupivacaine 0.5% (THA) was used in all cases combined with LIA with a catheter and subsequent bolus injections [8]. In addition, a standardized programme was followed in the operating theater, including fluid plans [9], use of tranexamic acid [10], small standard incisions (posterior for THA, midline skin and medial parapatellar for TKA), no drains, use of compression bandages [11] and cooling. Multi-modal opioid-sparing analgesia (NSAID, paracetamol, gabapentin, local analgesia) and early mobilization has facilitated a continuing reduction in LOS [7, 8].

All TKA patients were operated with tricompartmental cemented prosthesis. Surgery was done in a bloodless field by using a femoral tourniquet (inflated to 100 mmHg above systolic blood pressure) from incision until cementation of the prosthesis was finished. 500 mg of intravenous tranexamic acid was administered 15 min before incision, and another 500 mg just before tourniquet release.

All THA patients were operated with an uncemented cup and either a cemented or an uncemented stem. 15 min before incision, 1,000 mg of intravenous tranexamic acid was administered. Immediate and full weight bearing was allowed.

All the patients were discharged directly to their home and the discharge criteria were strictly functional: ability to get in and out of bed, get dressed, get into and up from a chair, ability to walk independently for 50 m with appropriate walking aids and acceptance of discharge [5]. LOS was counted as number of nights hospitalized after operation.

DVT prophylaxis consisted of low molecular weight heparin (LMWH, enoxaparin 40 mg s.c.) starting 6–8 h postoperatively and continuing once daily in the evening until discharge. No extended prophylaxis was given and also no mechanical devices were used (including compression stockings). No attempt was made to identify high-risk patients as all the patients received the same regimen. Postoperative bladder catheters were not used routinely.

Patients were mobilized on the day of operation. During 2004–2006, patients were mobilized in the afternoon or evening; but from 2007, the LIA technique has made a more aggressive mobilization possible, usually within 2–4 h after the operation. The pain treatment initially consisted of NSAIDs and paracetamol with opioids for breakthrough pain; but since 2007, a standardized pain treatment package has been given to all patients: (1) before surgery, gabapentin 600 mg, paracetamol 1 g and celecoxib 400 mg and (2) after surgery, gabapentin 300 + 600 mg, slow-release paracetamol 2 g/12 h and celecoxib 200 mg/12 h with oxycodone 10 mg on request.

All the patients are registered in the national health register where all readmissions at any hospital in Denmark are registered, when they are operated and all the readmissions or deaths within 90 days from the index arthroplasty operation were registered. All the records were scrutinized for reason of readmission, number of days hospitalized during readmission and whether the readmission was linked to the index arthroplasty operation—in case of doubt whether the readmission was due to complications associated with the prior arthroplasty operation, the readmission was counted as being linked (in order not to underestimate the real number of readmissions). The following readmissions were found to be potentially linked to the index arthroplasty operation: DVT (both found and suspected/not found), pulmonary embolism (PE), infection (found and suspected/not found), sequelae (pain, wound problems, decreased ability to move/ROM), fractures near the operating site, dislocation (hip/patella), manipulation, quadriceps rupture, myocardial infarction, stroke, pneumonia, gastro-duodenal morbidity and urinary tract infections.

Death following readmission and death without readmission were analyzed and registered. All deaths were followed by autopsy except in one case and the diagnosis was recorded and linked to the operation if a clotting episode or another possible operation-linked complication was involved. In the case where autopsy was not performed, death was assumed to be linked to the operation.

The study was presented for approval by the Ethics Committee but was found not to require approval and was

not registered with http://ClinicalTrials.gov under the US National Library of Medicine as it was considered a quality control study.

All data analyses were conducted with SPSS for windows, ver. 13.0 (SPSS Inc., Chicago, IL). Fisher's exact test and Chi-square test were used to compare incidences, $p < 0.05$ was considered significant. 95% confidence intervals (CI) are indicated where appropriate.

Results

From 2004 to 2008, 1,731 primary unilateral operations were performed: 947 THA and 784 TKA. Mean age was 69 years (24–94). Length of stay (LOS) has been decreasing during the study period with mean values from 4.6 to 3.1 days for TKA and from 6.3 to 3.9 days for THA.

Within 90 days postoperatively, 14 patients died (0.8%) and 225 patients were readmitted. 122 patients were readmitted following TKA [15.6% (CI: 13.19–18.26)] whereas 103 patients were readmitted after THA [10.9% (CI: 9.05–13.02)]. The risk of readmission was significantly higher after TKA compared to THA ($p = 0.005$). A total of 720 days of hospitalization after readmission was recorded after TKA as compared to 749 days after THA.

Table 1 shows specific reasons for readmission with incidences, 95% CI and number of additional days in hospital due to readmission. Also, a ranking of the reasons for readmission is presented. The specific reasons for readmission were as follows.

Deaths

From 2004 to 2008, 14 patients died within 90 days of surgery: 3 in 2004 [mesenterial thrombosis (89 days), myocardial infarction (2 days), sepsis/pneumonia (27 days)]; 3 in 2005 [hepatic cirrhosis and coma (28 days), perforated colonic cancer (51 days), sudden death (1 day, no autopsy)]; 3 in 2006 [metastatic lung cancer (77 days), dysregulated warfarin treatment (resulting in massive bleeding) for atrial fluttering (50 days), perforated gastric ulcer (22 days)]; 4 in 2007 [cardiomyopathy and failure (89 days), lung cancer (10 days), mechanical bowel obstruction (76 days), hepatic cirrhosis with esophageal bleeding (83 days)] and 1 in 2008 [aortic stenosis, pulmonary insufficiency and cardiac failure (19 days)].

Thus, 2 deaths in 2004 (1 THA and 1 TKA) may be related to clotting episodes and 1 in 2005 (TKA), 0 in 2006, 0 in 2007 and 0 in 2008 giving an all-over risk of VTE-related mortality of 0.17% (CI: 0.06–0.5). Deaths possibly related to postoperative complications following the index arthroplasty operation were: 1 in 2004, 1 in 2005, 1 in 2006, 0 in 2007 and 1 in 2008, giving an overall potential surgery-related mortality rate of 0.35% (TKA + THA, CI: 0.16–0.76).

Table 1 Incidences of readmission within 90 days after TKA and THA due to specified reasons

	Relative risk (%) TKA	95% CI	Readmitted (days, total)	Ranking	Relative risk (%) THA	95% CI	Readmitted (days, total)	Ranking
DVT, suspected	5.9	4.43–7.74	117	1	3.5	2.49–4.85	69	1
Dislocation	–	–	–	–	3.5	2.49–4.85	254	2
Infection (deep)	1.8	1.07–2.98	258	2	0.6	0.29–1.37	175	5
Sequelae	1.8	1.07–2.98	85	2	1.3	0.73–2.21	82	3
Infection, suspected	1.5	0.88–2.66	19	4	0.3	0.11–0.93	4	6
DVT	1.2	0.61–2.17	67	5	0.2	0.06–0.76	12	7
Fractures	–	–	–	–	1.0	0.50–1.80	128	4
Manipulation	1.0	0.52–2.0	28	6	–	–	–	–
Infection (superficial)	0.9	0.43–1.83	18	7	0.1	0.01–0.69	3	10
Myocardial infarction	0.6	0.27–1.49	38	8	0.2	0.06–0.76	6	7
PE	0.5	0.20–1.30	28	9	0.2	0.06–0.76	16	7
Quadriceps rupture	0.4	0.13–1.12	62	10	–	–	–	–
Stroke	–	–	–		–	–	–	
Pneumonia	–	–	–		–	–	–	
Urinary tract infections	–	–	–		–	–	–	
Pressure ulcers	–	–	–		–	–	–	
All	15.6	13.19–18.26	720	–	10.9	9.05–13.02	749	–

95% confidence intervals, total days of readmission for the specific diagnoses and subsequent ranking with the lowest number indicating the highest relative risk

Pulmonary embolism

From 2004 to 2008, 6 patients had confirmed pulmonal embolism (PE)—diagnosed by perfusion–ventilation lung scintigraphy—4 in the TKA group and 2 in the THA group leading to a 0.51% incidence in TKA and 0.21% in THA. All PE occurred within 30 days postoperatively. A total of 44 days of readmission followed PE diagnosis (28 days for TKA, 16 days for THA).

DVT

A total of 11 clinical DVTs were found within 90 days from 2004 to 2008. The clinical diagnosis was confirmed by an elevated D-dimer and a positive ultrasound examination: 9 in the TKA group and 2 in the THA group. Only 2 DVTs were found between 30 and 90 days (1 THA, 1 TKA). The 11 patients with DVT were readmitted for a total of 79 days (TKA 67 days, THA 12 days).

DVT suspected, not found

79 patients (46 TKA, 33 THA) were readmitted for suspected DVT, but the diagnosis was excluded by ultrasound and D-dimer measurements. They made an additional 186 days of rehospitalization (117 days TKA, 69 days THA).

Infection

21 patients operated with TKA were readmitted for infection; 7 were superficial and handled with antibiotics. 14 infections were deep; 6 required prosthesis removal and 8 had a soft tissue procedure (debridement and antibiotics). A total of 276 days were utilized for readmission due to infection after TKA. 7 patients operated with THA were readmitted for infection; 1 was superficial. 6 infections were deep and required surgical intervention: 3 had a two-stage revision with an intermittent antibiotic-loaded cement-spacer and 3 had only a soft tissue operation. 178 days in total were required for readmissions due to infection after THA. An additional 15 patients were readmitted for suspicion of infection, which was not found (normal CRP, SR and WBC, no drainage, followed in outpatient clinic with no subsequent development of infection); 12 following TKA and 3 following THA.

Sequelae

26 patients were readmitted, 14 following TKA and 12 following THA: due to pain (8), poor mobilization (10), episodes of falling (3), anemia (2), dizziness (2) and hematoma (1) after discharge. They utilized a total of 167 days (TKA 85 days, THA 82 days).

Fractures

Nine patients—all after THA—were readmitted because of fractures that may be related to the operation. 1 fracture was of the acetabulum, 8 of the femur in proximity with the prosthesis—of these, 4 had a prior fall. All fractures necessitated re-surgery with ORIF and/or stem change, requiring a total of 128 days.

Dislocation

A total of 51 dislocations occurred in 33 patients within 90 days after THA. The incidences were between 1.7 and 6.9% for each year (6.9% for 2004 with the longest LOS); a significantly reduced risk of dislocation was found with decreasing LOS comparing each year from 2005 to 2007 with the index year being 2004 whereas a tendency towards the same was seen in 2008 ($p = 0.13$). No significant difference was found between the years 2005 and 2008. All dislocations were treated by closed reduction and no open re-surgery was performed within 90 days. A total of 254 days of readmission after dislocation were required.

No patella dislocation was seen.

Manipulation

8 manipulations (brissement forcè) were performed within 90 days of TKA: 2 in 2004, 2 in 2005, 3 in 2006, 0 in 2007 and 1 in 2008. The indication for performing closed manipulation was unaltered during the 5-year period: lack of ability to flex $\geq 90°$ at 6 weeks (evaluation by physiotherapist) or lack of progression of flexion during the weeks of supervised training. No association was found between LOS and incidence of manipulation. 28 days were required in total for rehospitalization after manipulation.

Quadriceps rupture

Three cases of quadriceps rupture after falling on a flat surface after discharge were seen and requiring reoperation, utilizing 62 additional days.

Myocardial infarction

5 patients after TKA and 2 patients after THA developed myocardial infarction (apart from the one patient, who died from a myocardial infarction after TKA in 2004). 38 and 6 days, respectively, required for readmission for this condition.

Stroke

No patient was readmitted with a stroke.

Pneumonia, gastro-duodenal morbidity and urinary tract infections

No patient was readmitted with or due to any of these conditions.

Table 1 shows that the relative risk of readmission is higher following TKA than THA while comparing diagnoses of readmission applicable for both groups.

Tables 2 and 3 show readmissions after TKA and THA, respectively, with number of readmissions and number of operations each year. Also, the tables show the adjusted numbers of readmission, the patients readmitted for suspicion of DVT or infection not present, are excluded. Total rates of readmission (adjusted) are 8.0% for TKA and 7.3% for THA ($p = 0.39$).

There was no difference between readmission rates per year for either TKA or THA, whether the rates were adjusted or not (NS).

Discussion

This study gives specified complication rates necessitating readmission in an unselected patient population, with a consecutive fast-track setup and a 100% follow-up for 90 days using the unique Danish National Health register to record all national readmissions and the Danish Personal register to assess mortality.

We found an overall incidence of death of 0.17% potentially related to the operation (clotting episodes), which is lower or comparable to previous studies where postoperative mortality is validated regardless of type (whether chemoprophylactic or mechanical) or duration of thromboprophylaxis (up to 36 days) [12–21]. The standardization with use of regional analgesia and early mobilization combined with short hospitalization may be important in obtaining such low morbidity [22].

Comparison of readmission rates between the studies is difficult as readmissions are defined differently and include varying diagnoses in the published studies and also depends on the thresholds for readmission by patients and physicians, presence of comorbidities, access to diagnostic tools, beds, the completion of follow-up, etc. Also, the same complication may be treated in an outpatient setting in one institution and during readmission in another (i.e., suspicion of DVT or wound infection). In one study, 10.8–28.1% of patients had complications with diagnoses of DVT, infection, dislocation, decreased range of motion, which would have required readmission in our setting, but only 4.3–13% were actually readmitted [23]. These limitations must be considered when comparing readmission rates. However, a recent meta-analysis on the effect of clinical pathways in joint replacement concluded that no study comparing a clinical pathway with standard care has shown an increased rate of readmission in general with hospitalization ranging from about 3.2 to 12.8 days [1].

Table 2 Readmissions per year following TKA and readmissions adjusted for suspicion of DVT/infection, none found

TKA	Readmissions/ operations	Readmissions adjusted	Readmissions (%)/readmissions adjusted (%)	LOS TKA
2004	16/124	6	12.9/4.8	4.4
2005	21/167	13	12.6/7.8	4.6
2006	22/159	16	13.8/10.1	4.5
2007	32/182	15	17.6/8.2	3.1
2008	31/152	14	20.4/9.2	3.2
Total	122/784	64	15.6/8.0	

All statistical comparisons (Chi-square): NS

Table 3 Readmissions per year following THA and readmissions adjusted for suspicion of DVT/infection, none found

THA	Readmissions/ operations THA	Readmissions adjusted	Readmissions (%)/readmissions adjusted (%)	LOS THA
2004	23/159	17	14.5/10.7	6.3
2005	18/179	10	10.1/5.6	5.3
2006	19/217	14	8.8/6.5	5.7
2007	22/199	12	11.1/6.2	4.2
2008	21/193	14	10.9/7.3	3.9
Total	103/947	67	10.9/7.3	

All statistical comparisons (Chi-square): NS

Postoperative infection necessitating readmission was found in 1.7% of which 1.2% was deep infection requiring re-surgery and 0.5% was superficial. Another study found incidences of 1.1% deep infection (6 weeks) and 14.3% superficial infection after total hip and knee arthroplasty [24]. A variety of incidences can be found for infection in the literature, but a recent large register study (97,344 THAs) from The Norwegian Hip Arthroplasty Register found an increase in the risk of hip revision due to deep infection during 1987–2007, with a risk of 0.63% for the period 2003–2007 [25]. Also, another large register based study on 69,663 TKAs found an incidence of 1.6% revisions due to deep infection [26]. These incidences are comparable to the ones found in our study, but include only revisions and not soft tissue procedures without prosthetic removal.

Sequelae after TKA and THA in the form of poor mobilization including fall episodes—anemia, dizziness and hematoma—are common, but led to readmission in only 1.5% of the patients in this series. These diagnoses constitute a minor complication and different local thresholds and access to rehabilitation facilities will affect readmission rates.

Fractures following fall episodes after discharge are not believed to be linked to LOS in our series, as functional discharge criteria—including ability to walk independently with crutches—are fulfilled before discharge.

Dislocation after THA was on average 3.5%. A meta-analysis found a mean rate of early dislocation of 4.5% with the posterior approach without soft tissue repair [27]. We found a reduced rate of dislocation while decreasing LOS from 6.3 to 3.9 days, in contrast with Mauerhan et al. [2] who found an increasing rate from 0.5% to 3.9% with LOS decreasing from 6.3 to 3.9 days. Our large study with complete follow-up therefore does not support an increased dislocation rate with fast-track THA.

Two studies found the rate of manipulation after TKA to increase: from 6 to 14% while reducing LOS from 7.2 to 4.2 days [3] and from 6 to 12% while reducing LOS from 6.4 to 4.4 days [4]. The indication for manipulation was similar to ours ($\leq 90°$ of flexion at 6 weeks). However, no cause was identified for this increase and it was concluded that from an economical point of view, an increase in LOS in order to avoid manipulations could not be justified. Since we found no increase in manipulations when LOS was reduced from 4.6 to 3.1 days and, as the rate of manipulation was 1% for the period, it is concluded that fast track TKA does not increase the risk of manipulation.

Three cases of quadriceps rupture were seen after TKA. Few reports exist on the occurrence of this relatively rare complication—a prevalence of 0.1% has been reported [28].

Myocardial infarction occurred in 0.4% of the patients, lower than the incidence of 1.8% reported by others [29].

The readmission rates of 8.0% for TKA and 7.3% for THA excluding the readmissions for suspicion of DVT and infection are comparable to rates in the literature [4, 23, 30–34]. A substantial reduction in readmissions could be achieved by avoiding readmission for suspicion of DVT or infection as these potential complications account for almost half the readmissions. Establishing open outpatient visits with the possibility of performing acute diagnosis of DVT or infection would enable an experienced surgeon to minimize unnecessary readmissions.

In conclusion, our study shows that fast-track TKA and THA does not increase the readmission rate, that readmissions in general are more frequent after TKA than THA and that dislocation after THA and manipulation after TKA do not increase as LOS is decreasing.

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