Fast track rehabilitaion after knee arthroplasty

Morency, Adrian Charles

Master's thesis / Diplomski rad

2016

Degree Grantor / Ustanova koja je dodijelila akademski / stručni stupanj: **University of Zagreb, School of Medicine / Sveučilište u Zagrebu, Medicinski fakultet**

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:105:773938

Rights / Prava: In copyright / Zaštićeno autorskim pravom.

Download date / Datum preuzimanja: **2024-03-28**



Repository / Repozitorij:

Dr Med - University of Zagreb School of Medicine Digital Repository







THE UNIVERSITY OF ZAGREB

SCHOOL OF MEDICINE

Adrian Morency

Fast track rehabilitation after Knee Arthroplasty

GRADUATE THESIS

Zagreb, 2016.

This graduate thesis was made at Department of Orthopaedic Surgery, University Hospital Zagreb, Salata 7, Zagreb mentored by Prof. dr. sc. Domagoj Delimar, dr. med. and was submitted for evaluation in the academic year of 2015/2016.

ABBREVIATIONS

LOS- length of stay

TKA- total knee arthroplasty

THA- total hip arthroplasty

DVT- deep vein thrombosis

PE- pulmonary embolism

VTE- venous thromboembolism

LMWH- low molecular weight heparin

TEA- tranexamic acid

TUG- timed get up and go test

WDT- walking distance test

FIM- functional independence test

NRS- Numeric rating scale

NSAID-Non-steroidal anti-inflammatory drugs

WOMAC- western Ontario and McMaster universities osteoarthritis index

Summary

Fast Track Rehabilitation in Complete Knee Arthroplasty

Adrian Morency

Historically, patients were usually hospitalized for several weeks after total knee arthroplasty (TKA), which mainly consisted of a period of bed rest. [1]However, the length of hospital stay after TKA has decreased in the last decade through implementation of fast-track protocol.[2-6]

Moreover, the quality of life after TKA with fast track improves substantially during the first 3 months after hospital discharge, compared to the quality of life of patients treated with a non-fast-track protocol.[7] Also, a decrease in the number of complications and re-admissions can be achieved with the fast track rehabilitation protocols.[8,9]

The prevalence of manipulation under anesthesia for stiffness of the knee has been found to be lower or comparable with the use of fast-track protocols, compared to conventional pathways[4] and the risk of thromboembolic complications is reduced.[10] Fast-track protocols have proven to be safe for patients, including the elderly.[11]

Key words: Total knee arthroplasty, fast track, rehabilitation.

Table of Contents

1.Introduction.....1

2.Overview of Protocol..... …….2

2.1Preoperative ..... ……2

2.2 Perioperative..... ……..3

2.3 Postoperative…….....3

3.Surgical Technique……4

4.Tourniquet…….5

5.Thrombosis Management…….7

6. Rehabilitation…….10

6.1 Pre-operative Rehabilitation Protocols……10

6.2 Rehabilitation Program…….11

6.3 Standard Postoperative Rehabilitation……..13

6.4 Fast Track postoperative rehabilitation……..13

7. Pain Relief……14

7.1 Intraoperative Interventions……15

7.2 Postoperative Pain control……17

8. Home Care…….18

9. Conclusion……20

10. Acknowledgements……21

11. References……22

12. Biography……34

1. Introduction

The world's population is ever ageing and the demand for joint replacements are on the rise. In recent years, the stress for health care budgets to afford these joint replacements are at a all time high and patients are placed on a waiting list for over a year in some countries.

In some countries, the introduction of fast track rehabilitation has been shown to reduce the total period of length of stay in hospital. "Over the last decade, length of stay (LOS) with discharge to home after primary THA and TKA has declined from about 5–10 days to about 2–4 days in selected series and larger nationwide series".[12]

TKA have been shown over the years to be a mainstay orthopedic procedure enabling patients to regain good knee joint function after suffering from debilitating end stage knee osteoarthritis and knee pain.[13]

The criteria for selecting good candidates to be on the fast track protocol for total knee arthroplasty (TKA) is dependent on psychosocial factors, preoperative pain and functional status[2] or "whether organizational or pathophysiological factors in relation to the surgical trauma may determine the length of stay.[14,15]

The introduction of a good physical rehabilitation regimen is an essential part in decreasing the amount of muscle strength and functional performance loss realized shortly after the procedure.

There have been recent concerns over fast track rehabilitation and whether or not they have been leading to a greater incidence of post surgery fall related admissions. The evolution of fast track rehabilitation in TKA and the integration of these practices in mainstream medicine world wide

will hopefully further improve the quality of life, reduce pain and keep overall health care cost down.

2. The fast track procedure Overview

2.1 Preoperative

Patients are evaluated to qualify them for TKA fast track protocol via psychosocial factors, preoperative pain, functional status and whether organizational or pathophysiological factors from the surgical trauma may determine the length of stay in hospital.[16]

The inclusion criteria for fast track rehabilitation in TKA in some studies are the following. The procedure is elective, patients must be over the age of 18 years, it must be a primary procedure consisting of unilateral nature with knowledge of the local language where the procedure is taken place.[16] An exclusion protocol consist of preoperative physical capacity test which has been shown to increase the success of candidates on the fast track protocol. [16]

Limiting factors ranged from patients suffering from rheumatoid arthritis, polyneuropathy or extremity paresis. "Exclusion criteria were: patients with revision TKA surgery, patients with an insufficient command of Dutch, mentally disabled patients, and patients in which a prosthesis in another joint of the ipsilateral or contralateral lower limb had been replaced within 6 months before TKA surgery. All patients received the NexGen prosthesis (Zimmer, Warsaw, IN) through an anteromedial approach."[18]

2.2 Perioperative

Perioperative care includes multidisciplinary education preoperatively, standardized anesthesia and analgesia, standardized surgical technique and standardized postoperative rehabilitation initiatives (ambulation<4 h postoperatively).[14] In some European countries where fast track protocols have been adopted, the standard protocol preoperatively for TKA

in Denmark are to start patients on oral gabapentin (600 mg), slow-release paracetamol (2g), and celecoxib (200 mg) (Hvidovre) or todolac (200 mg) (Holstebro), patients are given this combination twice a day for 6 days, except for gabapentin, which was given in a 300 mg dose and patients would receive up to 600 mg more throughout the day.[18]

Currently patients are operated under lumbar spinal anesthesia: 7.5mg isobaric bupivicaine(0.5%) for TKA and are given propofol (1–5 mg kg-1 h-1) this was supplemented to the patients sedation if there was any discomfort or additional requirement. [18]

For the control of bleeding and to decrease the risk of infection patients are given Cefuroxime (1.5 g) and tranexamic acid (1 g) intravenously 15 min before incision.[18] During the fast track protocol drains are not used and patients are generally operated using a medial parapatellar approach.[18] Intraoperative local infiltration analgesia (LIA) is used during TKA and Postoperative rescue analgesia consisted of oral morphine (10 mg).[18]

2.3 Postoperative

The standard postoperative rehabilitation protocol consist of mobilization only hours after the surgery. Patients are subjected to weight bearing ambulation on assisting devices, physiotherapy twice daily, which includes transfer training and walking techniques.[16]

Every session with the physiotherapist, education is one of the main focuses to ensure proper patient compliance for their daily exercise program and daily activities patients are permitted to take part in.[18]

3. Surgical Technique

There are different surgical approaches regarding TKA that can be used. During conventional surgery the standard approach used is the medial parapatellar approach. This approach enhances accessibility to the entire knee joint however it compromises the extensor mechanism and the blood supply to the patella. These two limitations have a direct impact on the patient by delaying their ability to initiate physiotherapy postoperative. [19-21]

The midvastus approach involves making an incision into the midsubstance of the vastus medialis, thereby allowing the quadriceps tendon's attachment to be spared and function will be still in tact.[19, 23]

Further advantages of this approach are that it enhances the patellofemoral stability, quadriceps control, reduced scarring in the quadriceps tendon, improved flexion 1 week postoperatively, improved visual analogue pain scales while not impacting the complication rates or quadriceps function.[19] The disadvantage to this approach is that it lacks complete knee exposure during the procedure compared to the later.[20]

The subvastus approach's mainstay is that it preserves the quadricep mechanism, this is achieved by separating the vastus medialis at the intermuscular septum.[20] This approach has showed to

enable patients to achieve a rapid rehabilitation, improved pain scores and decreased the amount of lateral releases. The drawbacks to this technique are knee exposure is limitation, decreased quadricep strength in early postoperative period as compared to subvastus group.[20,21,23,24]

The criteria for minimally invasive surgery of the knee joint is described by making an incision of less than 140mm in length, a smaller quadriceps incision, subluxation of the patella and no dislocation of the tibial femoral joint.[25] There has a been an emergence of studies in recent years of surgeons utilizing this technique however results haven't been conclusively of the clear advantage of MIS over the conventional approaches.

However, MIS does provide patients with a smaller incision, therefore enabling a better cosmetic outcome and early rehabilitation.[26] In one study where the 3 cited approaches for TKA and MIS were compared and there was no significant differences in outcome postoperative WOMAC score, knee society score or the frequency of early complications.[26]

4. Tourniquet

During TKA it is a common procedure to complete this operation with the assistance of a tourniquet.[27] It's a common consensus between orthopedic surgeons that the use of a tourniquet offers a better visualization of all structures, decreases the total amount of blood loss and enables surgeons a better quality of cementing and other surgical procedures during the procedure.[28]

It was reported by Yavarikia et al. That the use of a tourniquet decreases the total intraoperative procedure time.[29] In a prospective study by Willis-Owen et al. it showed that patients who underwent a prolonged operating time, had an increased risk of contracting an infection.[30]

Unfortunately there also have been some complications reported with the use of a tourniquet while completing the TKA. These are DVT, PE, skin blistering, hematoma, wound oozing, muscle injury, rhabdomyolysis, nerve palsy and post operative stiffness[29]. Thus these complications can lead prolonged recovery time postoperatively and increased pain and can could ultimately lead to even more serious consequences such has renal failure and death in some cases.[29]

Furthermore, it was reported by Zhang et al that the postoperative ROM was decreased in TKA under tourniquet and therefore delayed the initiation of rehabilitative protocols. "Wakankar et al. showed 9.48° difference in favor of TKA without tourniquet over TKA with a tourniquet.[31]A likely reason for this finding could be the nerve and muscle damage which occurs under tourniquet which has been found to cause nerve palsy's or rhabdomyolysis.[31]

Parmet et al. reported that tourniquets used in patients were at a 5.33-fold greater risk of having a large emboli compared with TKA without a tourniquet.[32] This risk of thrombi is due to the triad of venous stasis, endothelial damage and damage to calcified vessels. Zahavi et al. reported that tourniquet use is associated with ischemia and thus causes an increase in levels of plasma beta-thrombolobulin and plasma thromboxane-B2, while these two parameters are related to increasing the risk of thrombosis in patients undergoing TKA.[33]

A study from Harsten et al found that by not using a tourniquet that it didn't influence the patients overall knee extension strength after the first 48 hours after recovery under fast track TKA protocols compared to a group which used the tourniquet.[34] It is obvious that that there is a conflict of data in between studies and on the benefits of using a tourniquet in fast track TKA

protocols. More research must be performed to ensure the future success of further evolving and implementing fast track procedures world wide.



Fig.1 Tourniquet under Total Knee Arthroplasty

5. Thrombosis management

Total knee arthroplasty is associated with certain risk factors and therefore management must be complete. Factors such as long immobilization periods which increase the perioperative risks which may lead to deep vein thrombosis (DVT) and pulmonary embolism (PE).[35-37] These thrombogenic events arise from the development of venous thromboembolism (VTE) and can lead to a post-thrombotic syndrome or death.[38, 39]

The current DVT protocols as stated by the American College of Chest Physicians which states that there is a minimum of 10 days prophylaxis after TKA.[40] Their guidelines recommend LMWHs, vitamin K antagonists, or fondaparinux (injection form of factor Xa inhibitor) for at least 10 days in patients undergoing TKA.[41]

In the past years studies have found that the risk of DVT has dropped due to protocols favoring early immobilization and a short hospital stay which is consistent with fast-track protocols.[42]

The pharmacological protocols consist of Low Molecular Weight Heparins (LMWH). In centers which have not implemented fast track protocols, the standard daily subcutaneous injection in hospital can be incorporated. However, in fast track protocols, where the hospital stay is minimal the oral LMWH must be implemented.

Rivaroxban is taken orally and therefore can be prescribed and patients can be discharged home sooner. Furthermore, there isn't a need to monitor blood levels and there isn't any need of adjusting the doses given of 10mg daily. Rivaroxban inhibits factor Xa and is licensed for the use for TKA as a thromboprophylaxis.[43, 44] There has been many studies which have studied the efficacy of the Rivaroxban 10mg versus enoxaparin 40 mg daily and studies showed an increase of efficacy against VTE.[45,46]

However patients which were taking Rivaroxban were subsequently under a greater risk of bleeding complications, which is associated with a greater risk of deep infection or subsequent major surgery.[47] Furthermore, the use of tranexamic acid (TEA), which is an inhibitor of fibrinolysis is being used as a remedy for decreasing the total amount of perioperative blood loss, which decreases the need for blood transfusion.[47]

Table 4 Kaplan–Meier event rates and rate difference per 10,000 patients after total hip arthroplasty and total knee arthroplasty over treatment and follow-up period

End Point	events per 10,000 patients		Rate difference
	Rivaroxban	Enoxaparin	(per 10000 patients) (rivaroxaban-Enoxap)
RECORD313 and RECORD414 (day 47) – total knee arthroplasty			
symptomatic VTe plus all-cause mortality	121	219	□98 (−169 to □27)
symptomatic VTe	102	178	□75 (−140 to □11)
all-cause mortality	23	42	□19 (−50 to 12)
Major bleeding	75	48	26 (−16 to 68)
Nonfatal major bleeding	71	48	23 (−19 to 64)
Nonfatal major bleeding leading to reoperation	49	30	19 (−15 to 52)
Nonmajor clinically relevant bleeding	278	242	37 (−48 to 122)
Nonfatal major plus surgical-site bleeding	**189**	**141**	48 (−20 to 116)
Major plus nonmajor clinically relevant bleeding	**342**	**290**	52 (−42 to 145)
Surgical wound infections	**159**	**181**	□22 (−92 to 48)
Surgical wound infections leading to rehospitalization/prolongation of hospitalization	**34**	**49**	□15 (−50 to 20)
serious adverse events	**832**	**1,038**	□206 (−367 to □45)

From the measurement standards of table 1 and the results from table 2 which the study by Levitan et all carried out, there is clear evidence of the advantages and the risks of incorporating Rivaroxaban into the fast track protocol. While treating patients there are many risk factors which must be taken into consideration, which out reach the formal benefit-risk assessment.[47]

For instance, when considering rivaroxaban and it's once a day oral formulation and it's standard international normalized ration monitoring but the lack of an available antidote conjures some controversy when determining the thromboprophylaxis of choice.[47] From the current research it is advisable to choose rivaroxaban over enoxaparin for thrombo-prophylaxis after TKA.[47]

6. Rehabilitation

6.1 Pre-operative Rehabilitation Protocols

In recent years research as shown that physiotherapy is a crucial aspect of good recovery and results in patients undergoing TKA. Studies have shown that patients can loose up to 80% of total knee extension strength post TKA.[49] A term has been created to describe this condition called arthrogenic quadriceps muscle inhibition. [49]

It is thought that the afferent signaling pathway in the operated knee is influenced by swelling, inflammation and damage to joint afferents, this leads to alterations in excitability in the CNS causing changes in multiple spinal and supraspinal pathways. [50]

In some centers specifically in Switzerland, the pre-operative programs include 6-12 weeks of neuromuscular training prior to the surgical intervention.[48] The protocol consist of training the non-affected leg to teach the patient how to transfer their body weight appropriately to the affected side to retrain proper neuromuscular function and position.[48]

Furthermore, closed kinetic exercises are performed in the lying, sitting and standing positions to further retrain biomechanical alignment of the knees and hips.[48] Thereby, enhancing biomechanical efficiency and realignment of their posture. Introduction of open kinetic exercises can be included to help the overall strength of the hip and knee muscles.[48]

6.2 Rehabilitation Program

The program is made up of three parts. In the first part the patient is required to warm. The warm us consist of a light 10 minute session on the stationary bike, the workload can be increased incrementally and is dependant on the patients capacity.[48]

The second part consisted of a circuit program, which was comprised of four exercises which focused on core stability, postural function, functional alignment, lower body muscle strength and functional exercises. Exercise volume is 2-3 sets per exercise with a target of 10-15 repetitions with rest between each set.

Furthermore, to enable progression of the exercise program patients are evaluated by the number of sets which are completed and once the patient completes the target amount, then the program difficulty is increased by increasing the load, changing the tempo and by changing the support surface. Thus, patients must show good neuromuscular control and must provide good control for the therapist to continue increasing the difficulty of the exercise program.[48]

In the third part of the exercise program, the essential element here is the cool down. This is comprised of approximately 10 minutes of forward and backward walking, about 10 meters in each direction, mobility exercises for the lower extremities and stretching exercises for the lower extremity muscles.[48]

In theory this neuromuscular training protocol should have a pronounced effect on the patients overall rehabilitation. However, the lack of studies, with a small sample sizes has proven only moderate benefits towards the overall recovery and rehabilitation of patients undergoing TKA.[52,53] I strongly believe that there is a lack of research for the benefits of preoperative strengthening and conditioning and with time the research will prove unequivocally the importance of these protocols.

In standard protocol for TKA patients prior to surgical intervention Patients are admitted to hospital. The physiotherapist will test the patients physical capacity through a variety of test. The patients are to perform a timed get up and go test (TUG), walking distance test (WDT), a stair test of the functional independence measures test (FIM).[54] Patients are expected during the TUG to stand up from a chair, walk 3 meters turn around, walk back to the chair and sit back down on the chair and the total time to completion was measured. During the WDT, patients were expected to walk as far as possible for 20 minutes, the results were calculated by the total distance that the patient was able to complete.

A distance of 400m or greater was considered to be an unlimited walking capacity. During the FIM ST test, the patient is expected to climb stairs and the patient is given a score between 1-7, 7 a high score represented the patients ability to complete the test independently.[54]

6.3 Standard postoperative rehabilitation

Patients are administered within the first 24 hours postoperatively a IV fluid program. On day 2, patients will be mobilized and prescribed 1 hour of physiotherapy such walking exercises, passive flexion and extension of the knee up 90-00-00, strengthening of the lower limb muscles, respiratory training. However, in most fast track rehabilitation programs the exercises which patients are prescribed are not so different. However patients are expected to start exercising within a shorter time period postoperatively and the duration of rehabilitation will last longer in patients undergoing a fast track protocol.

6.4 Fast-track postoperative rehabilitation

In the study done by Hertog et al, they used the Joint Care (Biomet Europe BV, The Netherlands) fast track rehabilitation protocol.[51] The program consisted of patients getting up on the day of the surgery, climbing stairs 48 hours postoperatively, 2 hours of intensive daily physiotherapy, the use positive affirmation messages to aid the patient through the protocol and using a competitive care technique which enables the patient to compete against other patients results and achieve the last milestone of day 6 discharge home if all the discharge criteria had been fulfilled. The patient was kept longer in hospital until discharge protocol had been satisfied.[51]

In this study the discharge protocol included the following: patients had to be able to walk 30 meters with crutches, climb stairs, dress independently, and go to the toilet independently. In addition, sufficient pain relief had to have been achieved by oral medication before discharge, with a numeric rating scale (NRS) pain score below 3 at rest and below 5 during mobilization.[51]

The results in this study indicate that the fast track rehabilitation group were discharged on average at 6.75 days, which is between day 5-7 post operative and on the standard operative group an average of 13.2 days.[51] The implementation of intense post surgical rehabilitation should be implemented for a longer duration, thus ensuring patients compliance and to gauge the potential of patients capacity to return to function.

A clinical study reported by Larsen et al. who concluded that there is a need for an additional postoperative rehabilitation after fast-track total knee arthroplasty and unicompartmental knee arthroplasty regarding early functional outcome; Patients who experienced no or only mild pain and who had good functional abilities at 4 months were associated with high health-related quality-of-life and patient satisfaction at 4- and 12-month follow-up.[51] Further research must be conducted to prove the statistical significance of longer post rehabilitative protocol to further progress patient care after TKA in this century.

7. Pain relief

Fast track rehabilitation of TKA's primary goal is movement as soon as possible. This is primarily achieved by adequate administration of analgesics. Without the use of analgesics the time before mobilization would be prolonged and it wouldn’t be feasible for the patients early discharge.

Currently there are studies which are implementing pre-emptive analgesia prior to surgical intervention. "Thus, preventing central sensitization of pain through blocking painful stimuli and afferent signals from the operative site.[55]

The oral analgesics which are utilized in this pre-emptive analgesia program are opioids, non-steroidal anti-inflammatory drugs (NSAIDs), acetaminophen, clonidine and ketamine.[57] In a study by Buvanendran et al patients were given 50mg or oral rofecoxib at 24 hours and 1-2 hours before TKA and continued on the regimen for up to 13 days post operative and were studied amongst a group which was administered a placebo.

It was found that the group which had been administered rofecoxib had less epidural analgesic need and opioid consumption, lower pain scores, less post operative vomiting, a decrease in sleep disturbance and needed less time in physical therapy to achieve specific range of motion targets as compared to the placebo group. Furthermore, it was found by Mallory et al when using cyclooxygenase-2 inhibitors for 2 weeks prior to TKA and continued for 10 days postoperatively that also resulted in a significantly shorter hospital stay.[57]

7.1 Intraoperative Interventions

Fast track TKA patients are operated under spinal anesthesia with 1.5-2.5 ml 0.5%(7.5-12.5 mg) hyperbaric or plain bupivacaine injected into L2/L3 or L3/L4 vertebral inter space with a standardized intraoperative regime for fluid administration of 0.9% saline (5mL/kg/h), colloid

(voluven; 7.5 mL/kg/h), tranexamic acid (1g) and no use of drains. Patients are operated using a standard midline incision and a medial parapatellar approach.[58]

Local infiltration anaesthesia (LIA) is a another technique utilized during the fast track protocol where they inject an infiltration of anaesthetic agents directly into the knee joint. In conjunction with this therapy, postoperative boluses are administered via intra-articular catheter enabling patients a high standard of pain relief and further enabling early mobilization.[57]



Fig.2 Local infiltration anaesthesia during Total Knee Arthroplasty

Kerr et al have been studying this technique since the late 1990's and which they have reported that their patients have experienced very good post operative pain control, less postoperative narcotic side effects, early mobilization, within hours of the surgery and in some patients next day postoperative discharge.[57]

7.2 Post operative pain control

Standard pain relief is accomplished by utilizing a multimodal oral-opioid sparing analgesia consisting of Cox2 inhibitor (celecoxib-200mg/12 hourly) paracetamol (slow release-2g/12 hourly), gabapentin (300mg morning and 600mg evening), with opioids being administered only upon request.[((58)]

In the study by Husted et al found using these fast track protocols they were able to discharge 80% of patients within 48 hours, with minimal problems with nausea, vomiting, sedation and confusion but with the implementation of a more intensive multimodal non-opioid pain management regime could be reduced further.[(59)] In a study by Ilfeld et al, they suggest that this analgesia protocol could be improved by utilizing a continuous peripheral nerve blocks, however this runs the risk of causing muscle weakness which could ultimately lead to an increase in prevalence of falls.[(60)] Although the use of continuous peripheral nerve blocks are the most effective analgesic technique they due come with a risk of muscle paralysis and the need of a experienced trained professional to ensure optimal placement.[(60)]

For further advancement in postoperative pain control more research must be dedicated into understanding large inter-individual variability in the degree in postoperative pain, which may be related to the inflammatory response and genes associated with pain. Thus, leading to optimal individual pain management protocol for patients who are low pain responders or high pain responders.[(62)]

8. Home care

Home base training can be a great solution for independent and motivated individuals. The cost for physiotherapy and hospital stays are ever increasing and solutions are necessary to help further develop economical strategies to enhance patient care without dramatically increasing costs. Currently, home based care commences as soon as the patient is discharged from the hospital.

Anywhere from 48 hours post operatively. As TKA are becoming more demanded so are the protocols to make this procedure more affordable and accessible for the entire population. Some limitations of TKA are long term strength deficiency, pain and disability in an operated leg even years after the procedure had been successfully completed. Home care can be implemented as a cost efficient measure to improve all these parameters.

In a study by Vuorenmaa et al, they administered a home care exercise program consisting of active and passive range of motion exercises, knee flexion and extensor exercises, hip adductor and extensor exercises in the standing position and slowly progressing their walking distance. Patients completed these exercises 1-2 times per week with a 10-15 repetitions.[34]

At the 2 month post operative mark a new exercise program was administered and the program consisted of squats, hack squats with the wall and step exercises. The patients progress was monitored and once a peak of 20 reps and 3 sets were attained then exercises were intensified. This program was used 3 times per week for the next 11 months.[62]

It was shown in this study that the use of a long term home exercise program improved the physical performance of patients by increasing maximal walking speed and knee flexion strength,

however the self reported pain and disability scores weren't different as compared to the control group. These scores were determined by the use of the WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) which measures pain, disability and stiffness in different groups. In the study of Moffet et al, which reported that a decrease in WOMAC scores in pain and disability were significant in the intervention group as compared to the normal care group at 2 months post-operative. However at the 12 month follow up these improvements were no longer apparent.[63]

Furthermore, Kauppila et al compared normal care and multidisciplinary rehabilitation after surgery which also confirmed no significant differences in WOMAC between these groups at the 12 month mark.[64] Piva et al. compared 2 different 6-week functional training programs and they didn't find any statistical differences in WOMAC in pain or stiffness subscales scores at the 6 month mark upon follow up.[65]

Even though, the increased improvement was isolated to increasing walking speed and strength there is a positive correlation to still further home exercise studies since walking is a basic human need which must be accomplished to sustain ourselves and decrease the chances of further injuries. Also, knee flexion strength is correlated with better balance and endurance to ascend staircases, which is important for every day function. In a study by Bade et al. Found that by increasing the amount of high intensity exercise, it correlated to increased ability to walk up stairs and performance on the walk test, compared to the low intensity group.[66]

Moreover, it is clear that a home base program has cost advantages but adherence to physical rehabilitation programs are always a limitation in long term studies of physical improvement. There is clear evidence that an intense rehabilitation program can increase the physical

performance of individuals by increasing strength and walking speed. There must be more studies with more professional contact to ensure complete compliance over the long periods of rehabilitation. This on it's own should enable the scientific community to further observe progression in individuals performances long term after TKA.

9. Conclusion

As the world's population ages, so do the demands of increasing the quality of life for individuals. The cost of joint replacement surgery is ever increasing and waiting lists haven't never been so long. Fast track rehabilitation in TKA is a concept, which should be implemented into mainstream healthcare system's. TKA's current hospital stay can last up to 2 weeks. While in fast track rehabilitation, patients can be expected to be discharged at 48 hours post operative.

This would equate to less expenditures on patients being hospitalized for long periods, free up more hospital beds which are a scarce in most hospital centers around the world and focus more on patients rehabilitation by implementing new protocols which enable patients to immediately take part in rehabilitation which will enable patients to have a shorter periods of disability and less pain post operatively. Further studies should be conducted on fast track rehabilitation in TKA to continue developing this procedure and improve it's overall efficiency and patients satisfaction to further increase patients mobility and decrease their pain.

10. Acknowledgements

It is with immense gratitude that I acknowledge the support help and motivation provided by my mentor Prof. dr.sc. Domagoj Delimar, without his agency this paper could not have been written. I would also like to thank my parents for their support, patience and unconditional love.

11. References:

1. Berger R A, Sanders S A, Thill E S, Sporer S M, Della Valle C. Newer anesthesia and rehabilitation protocols enable outpatient hip replacement in selected patients. Clin Orthop Relat Res 2009; 467 (6): 1424-30.

2.Weingarten S, Riedinger M S, Sandhu M, Bowers C, Ellrodt A G, Nunn C, et al Can practice guidelines safely reduce hospital length of stay? Results from a multicenter interventional study. Am J Med 1998; 105 (1): 33-40.

3. Kim S, Losina E, Solomon D H, Wright J, Katz J N. Effectiveness of clinical pathways for total knee and total hip arthroplasty: literature review. J Arthroplasty 2003; 18 (1): 69-74.

4. Husted H, Jorgensen C C, Gromov K, Troelsen A. Low manipulation prevalence following fast-track total knee arthroplasty. Acta Orthop 2015; 86 (1): 86-91.

5. 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.

6. Husted H, Jensen C M, 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 (1): 101-4

7. Larsen K, Sorensen O G, Hansen T B, Thomsen P B, Soballe K. Accelerated perioperative care and rehabilitation intervention for hip and knee replacement is effective: a randomized clinical trial involving 87 patients with 3 months of follow-up. Acta Orthop 2008; 79 (2): 149-59.

8. Dowsey M M, Kilgour M L, Santamaria N M, Choong P F. Clinical pathways in hip and knee arthroplasty: a prospective randomised controlled study. Med J Aust 1999; 170 (2): 59-62.

9. den Hertog A, Gliesche K, Timm J, Muhlbauer 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 (8): 1153-63.

10. Husted H, Otte K S, Kristensen B B, Orsnes T, Wong C, Kehlet H. Low risk of thromboembolic complications after fast-track hip and knee arthroplasty. Acta Orthop 2010b; 81 (5): 599-605.

11. Jorgensen C C, Kehlet H. Role of patient characteristics for fast-track hip and knee arthroplasty. Br J Anaesth 2013; 110 (6): 972-80.

12. Malviya A, Martin K, Harper I, Muller SD, Emmerson KP, Partington PF, Reed MR. Enhanced recovery program for hip and knee replacement reduces death rate . Acta Orthop. 2011;82(5):577–81.

13. Thomas Linding Jakobsen, Henrik Kehlet, Henrik Husted, Janne Petersen andThomas Bandholm. Early Progressive Strength Training to Enhance Recovery After Fast-Track Total Knee Arthroplasty: A Randomized Controlled Trial. Article first published online: 24 NOV 2014.DOI: 10.1002/acr.22405

14. 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(6):679–84.

15. Husted H. Fast-track hip and knee arthroplasty: clinical and organizational aspects . Acta Orthopaedica (Suppl 346) 2012;83:2–

16. Bente Holm, Thomas Bandholm, Troels Haxholdt Lunn, Henrik Husted, Peter Kloster Aalund, Torben Bæk Hansen and Henrik Kehlet. Role of preoperative pain, muscle function, and activity level in discharge readiness after fast-track hip and knee arthroplasty, Acta Orthop. 2014 December 19; 85(6): 686.

17. Adrianus den Hertog, Kerstin Gliesche, Jürgen Timm, Bernd Mühlbauer, and Sylvia Zebrowski. 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 Aug; 132(8): 1153–1163.

18. Kehlet H, Andersen LO. Local infiltration analgesia in joint replacement: the evidence and recommendations for clinical practice. Acta Anaesthesiol Scand. 2011;55(7):778–84.

19. Alcelik I, Sukeik M, Pollock R, Misra A, Naguib A, Haddad FS: Comparing the mid-vastus and medial parapatellar approaches in total knee arthroplasty: a meta-analysis of short term outcomes. Knee 2012, 19:229-236.

20.Cila E, Guzel V, Ozalay M, Tan J, Simsek SA, Kanatli U, Ozturk A: Subvastus versus medial parapatellar approach in total knee arthroplasty. Arch Orthop Trauma Surg 2002, 122:65-68.

21.Harwin SF: The medial parapatellar approach to the knee. J Knee Surg 2003, 16:43-47.

22. Engh GA, Holt BT, Parks NL: A midvastus muscle-splitting approach for total knee arthroplasty. J Arthroplasty 1997, 12:322-331.

23. Van Hemert WL, Senden R, Grimm B, van der Linde MJ, Lataster A, Heyligers IC: Early functional outcome after subvastus or parapatellar approach in knee arthroplasty is comparable. Knee Surg Sports Traumatol Arthrosc 2011, 19:943-951.

24.Bourke MG, Sclavos EK, Jull GA, Buttrum PJ, Dalton PA, Russell TG: A comparison of patellar vascularity between the medial parapatellar and subvastus approaches in total knee arthroplasty. J Arthroplasty 2012, 27:1123-7, .e1.

25. Bonutti PM, Mont MA, McMahon M, Ragland PS, Kester M: Minimally invasive total knee arthroplasty. J Bone Joint Surg Am 2004, 86-A(Suppl 2):26-32.

26. Luring C, Beckmann J, Haibock P, Perlick L, Grifka J, Tingart M: Minimal invasive and computer assisted total knee replacement compared with the conventional technique: a prospective, randomised trial. Knee Surg Sports Traumatol Arthrosc 2008, 16:928-934.

27.Benoni G, Fredin H. Fibrinolytic inhibition with tranexamic acid reduces blood loss and blood transfusion after knee arthroplasty: A prospective, randomized, double□blind study of 86 patients. J Bone Joint Surg Br 1996;78:434□40.

28.Hiippala S, Strid L, Wennerstrand M, Arvela V, Ma□ntyla□ S, Ylinen J, *et al.* Tranexamic acid (Cyklokapron) reduces perioperative blood loss associated with total knee arthroplasty. Br J Anaesth 1995;74:534□7.

29. Wei Zhang, Ning Li, Sifeng Chen, Yang Tan, Mohammed Al-Aidaros, and Liaobin Chen1, The effects of a tourniquet used in total knee arthroplasty: a meta-analy J Orthop Surg Res. 2014; 9: 13.

30. Burg A, Dudkiewicz I, Heller SS. The effects of using a tourniquet in total knee arthroplasty: a study of 77 patients. J Musculoskelet Res. 2009;12(3):137–142. doi: 10.1142/S0218957709002286.

31. Wakankar HM, Nicholl JE, Koka R, D'Arcy JC. The tourniquet in total knee arthroplasty: a prospective, randomised study. J Bone Joint Surg (Br) 1999;1(81):30–33.

32. Parmet JL, Horrow JC, Berman AT, Miller F, Pharo G, Collins L. The incidence of large venous emboli during total knee arthroplasty without pneumatic tourniquet use. Anesth Analg. 1998;2(87):439–444.

33. Zahavi J, Price AJ, Westwick J, Scully MF, Al-Hasani SF, Honey AC, Dubiel M, Kakkar VV. Enhanced in-vivo platelet release reaction, increased thromboxane synthesis, and decreased prostacyclin release after tourniquet ischaemia. Lancet. 1980;8196(2):663–667.

34. Harsten A, Bandholm T, Kehlet H, Toksvig-Larsen S.Knee.Tourniquet versus no tourniquet on knee-extension strength early after fast-track total knee arthroplasty; a randomized controlled trial. 2015 Mar;22(2):126-30.

35. Heit JA, Melton LJ, Lohse CM, Petterson TM, Silverstein MD, Mohr DN, O'Fallon WM. Incidence of venous thromboembolism in hospitalized patients vs community residents. Mayo Clin Proc. 2001;76((11)):1102–10.

36. Seddighzadeh A, Zurawska U, Shetty R, Goldhaber SZ. Venous thromboembolism in patients undergoing surgery: low rates of prophylaxis and high rates of filter insertion. Thromb Haemost. 2007;98((6)):1220–5.

37. Sharma OP, Oswanski MF, Joseph RJ, Tonui P, Westrick L, Raj SS, Tatchell T, Waite PJ, Gandaio A. Venous thromboembolism in trauma patients. Am Surg. 2007;73((11)):1173–80.

38. Malone PC. A hypothesis concerning the aetiology of venous thrombosis. Med Hypotheses. 1977;3((5)):189–201.

39.Malone PC, Agutter PS. The aetiology of deep venous thrombosis. QJM. 2006;99:581–93.

40. Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, Colwell CW, American College of Chest Physicians Prevention of venous thromboembolism: American College of Chest

Physicians Evidence-Based Clinical Practice Guidelines (8th Edition) Chest (6 suppl) 2008;133:381S–453S.

41. Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, *et al.;* American College of Chest Physicians. American College of Chest Physicians: Prevention of venous thromboembolism: American College of Chest Physicians Evidence□Based Clinical Practice Guidelines (8th Edition). Chest 2008;133 (6 Suppl):381□453S.

42. Xing KH, Morrison G, Lim W, Douketis J, Odueyungbo A, Crowther M. Has the incidence of deep vein thrombosis in patients undergoing total hip/knee arthroplasty changed over time? A systematic review of randomized controlled trials. Thromb Res. 2008;123((1)):24–34.

43. Bente Holm, Thomas Bandholm, Troels Haxholdt Lunn, Henrik Husted, Peter Kloster Aalund, Torben Bæk Hansen, and Henrik Kehlet. Acta Orthop. 2014 December 19; 85(6): 686.

44. Clagett GP, Anderson FA Jr, Geerts W, Heit JA, Knudson M, Lieberman JR, *et al.* Prevention of venous thromboembolism. Chest 1998;114 (5 Suppl):531□60S.

45. Turpie AG, Lassen MR, Davidson BL, Bauer KA, Gent M, Kwong LM, *et al.* Rivaroxaban versus enoxaparin for thromboprophylaxis after total knee arthroplasty: A randomized trial. Lancet 2009;373:1673□80.

46. Lassen MR, Ageno W, Borris LC, Lieberman JR, Rosencher N, Bandel TJ, *et al*. Rivaroxaban versus enoxaparin for thromboprophylaxis after total knee artrhoplasty. N Engl J Med 2008;358;2776□86.

47. Bennett Levitan, Zhong Yuan, Alexander GG Turpie, Richard J Friedman, Martin Homering, Jesse A Berlin, Scott D Berkowitz, Rachel B Weinstein, and Peter M DiBattiste. Benefit–risk assessment of rivaroxaban versus enoxaparin for the prevention of venous thromboembolism after total hip or knee arthroplasty, asc Health Risk Manag. 2014; 10: 157–167.Published online 2014 Mar 26.

48. Erika O Huber, Rob A de Bie, Ewa M Roos, and Heike A Bischoff-Ferrari. The effect of pre-operative neuromuscular training on functional outcome after total knee replacement: a randomized-controlled trial, BMC Musculoskelet Disord. 2013; 14: 157.

49. Holm B, Kristensen MT, Bencke J, Husted H, Kehlet H, et al. (2010) Loss of knee-extension strength is related to knee swelling after total knee arthroplasty. Arch Phys Med Rehabil 91: 1770–1776doi:10.1016/j.apmr.2010.07.229.

50.Rice DA, McNair PJ (2010) Quadriceps Arthrogenic Muscle Inhibition: Neural Mechanisms and Treatment Perspectives. Semin Arthritis Rheum 40: 250–260.

51. Adrianus den Hertog, Kerstin Gliesche, Jürgen Timm, Bernd Mühlbauer, and Sylvia Zebrowski. Arch Orthop Trauma Surg. 2012 Aug; 132(8): 1153–1163.Published online 2012 May 27.

52. Wallis JA, Taylor NF. Pre-operative interventions (non-surgical and non-pharmacological) for patients with hip or knee osteoarthritis awaiting joint replacement surgery–a systematic review and meta-analysis. Osteoarthr Cartil. 2011;19(12):1381–1395. doi: 10.1016/j.joca.2011.09.001.

53.Gill SD, McBurney H. Does exercise reduce pain and improve physical function before hip or knee replacement surgery? A systematic review and meta-analysis of randomized controlled trials. Arch Phys Med Rehabil. 2013;94(1):164–176. doi: 10.1016/j.apmr.2012.08.211.

54. Ravaud JF, Delcey M, Yelnik A. Construct validity of the functional independence measure (FIM): questioning the unidimensionality of the scale and the "value" of FIM scores. Scand J Rehabil Med. 1999;31(1):31–41.

55. Dahl JB, Kehlet H. Preventive analgesia. Curr Opin Anaesthesiol 2011; 24: 331–338

56. Dalury DF, Lieberman JR, Macdonald SJ. Current and innovative pain management techniques in total knee arthroplasty. Instr Course Lect 2012; 61: 383–388.

57. Mallory TH, Lombardi AV, Fada RA*et al* Pain management for joint arthroplasty: preemptive analgesia. J Arthroplasty 2002; 17(4 Suppl 1): 129–133.

58. Henrik Husted, Troels H Lunn, Anders Troelsen, Lissi Gaarn-Larsen, Billy B Kristensen, and Henrik Kehlet. Why still in hospital after fast-track hip and knee arthroplasty? Acta Orthop. 2011 Dec; 82(6): 679–684. Published online 2011 Nov 25.

59.Husted H, Otte KS, Kristensen BB, Ørsnes T, Wong C, Kehlet H. Low risk of thromboembolic complications after fast-track hip and knee arthroplasty. Acta Orthop. 2010c;81:599–605.

60. llfeld BM, Gearen PF, Enneking FK, Berry LF, Spadoni EH, George SZ, Vandenborne K. Total knee arthroplasty as an overnight-stay procedure using continuous femoral nerve blocks at home: a prospective feasibility study. Anesth Analg. 2006a;102:87–90.

61. Henrik Kehlet and Kjeld Søballe. Fast-track hip and knee replacement — what are the issues? Acta Orthop. 2010 Jun; 81(3): 271–272.

62. Mirja Vuorenmaa, PT, MSc, Jari Ylinen, MD, PhD, Kirsi Piitulainen, PT, MSc, Petri Salo, PT, PhD, Hannu Kautiainen, BA Maija Pesola, MD, PhD and Arja Ha□kkinen, PhD. Efficacy of a12-Month, Monitored home exercise programme complared with normal care commencing 2 months after total knee arthroplasty: A randomized controlled trial. J Rehabil Med 2014; 46: 166–172

63. Moffet H, Collet JP, Shapiro SH, Paradis g, Marquis F, Roy L. Effectiveness of intensive rehabilitation on functional ability and quality of life after first total knee arthroplasty: A single-blind rand- omized controlled trial. Arch Phys Med Rehabil 2004; 85: 546–556.

64. Kauppila AM, Kyllonen E, Ohtonen P, Hamalainen M, Mikkonen P, Laine V, et al. Multidisciplinary rehabilitation after primary total knee arthroplasty: a randomized controlled study of its effects on functional capacity and quality of life. Clin Rehabil 2010; 24: 398–411.

65. Piva SR, Almeida J, Digioia AM, Levison TJ, Fitzgerald K. A balance exercise program appears to improve function for patients with total knee arthroplasty: a randomized clinical trial. Phys Ther 2010; 90: 880–894.

66. Bade MJ, Stevens-Lapsley JE. Early high-intensity rehabilitation following total knee arthroplasty improves outcomes. J Orthop Sports Phys Ther 2011; 41: 932–941.

12. Biography

Adrian Morency is a Medical student with the prospect to graduate in July 2016. Adrian Morency was born on the 11.06.1980 in Cornwall, Ontario, Canada. After completing High-School in 1999 from General Vanier Secondary School, Adrian Morency went on to complete a Univeristy degree in Human Kinetics and completed his B.Sc with Honors. After returning to Cornwall, On, Adrian Morency opened Quest Personal training studio's, where he worked as a Kinesiologist and co-owner. Since 2010, Adrian Morency is a medical student at the University of Zagreb, School of Medicine. He is proficient in English, French and Croatian. Currently Adrian Morency resides in Zagreb, Croatia.