ΤΜΗΜΑ ΙΑΤΡΙΚΗΣ
ΣΧΟΛΗ ΕΠΙΣΤΗΜΩΝ ΥΓΕΙΑΣ
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ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ
ΘΡΟΜΒΩΣΗ ΚΑΙ ΑΝΤΙΘΡΟΜΒΩΤΙΚΗ ΑΓΩΓΗ

Μεταπτυχιακή Διπλωματική Εργασία

"ΚΑΤΑΓΡΑΦΗ ΤΩΝ ΜΕΙΖΟΝΩΝ ΚΑΡΔΙΑΓΓΕΙΑΚΩΝ ΣΥΜΒΑΝΤΩΝ ΚΑΙ ΤΗΣ ΠΝΕΥΜΟΝΙΚΗΣ ΕΜΒΟΛΗΣ ΣΤΙΣ ΠΡΩΤΟΓΕΝΕΙΣ ΟΛΙΚΕΣ ΑΡΘΡΟΠΛΑΣΤΙΚΕΣ"

υπό

ΦΡΑΓΙΣΚΟΥ ΑΝΤ. ΑΓΓΕΛΗ

Ειδικευόμενου Ορθοπαιδικής

Υπεβλήθη για την εκπλήρωση μέρους των
απαιτήσεων για την απόκτηση του
Μεταπτυχιακού Διπλώματος Ειδίκευσης
«Θρόμβωση και Αντιθρομβωτική Αγωγή»

Λάρισα, 2021

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Τίτλος εργασίας στα αγγλικά:

Registration of the major adverse cardiovascular events and pulmonary embolism in primary total joint arthroplasty

ΕΥΧΑΡΙΣΤΙΕΣ

Στον Καθηγητή Αγγειοχειρουργικής κο Ματσάγκα Μ.

Στην Καθηγήτρια Αναισθησιολογίας κα Αρναούτογλου Ελ.

Στην Επιμελήτρια Ορθοπαιδικής κα Αρναούτογλου Χρ.

Περίληψη

Εισαγωγή: Αν και οι πρωτογενείς ολικές αρθροπλαστικές ισχίου (ΤΗΑ) και γόνατος (ΤΚΑ) θεωρούνται ασφαλείς επεμβάσεις, χαρακτηρίζονται από μικρό ποσοστό απειλητικών για τη ζωή μετεγχειρητικών επιπλοκών. Τα μείζονα καρδιαγγειακά συμβάντα και οι θρομβοεμβολικές επιπλοκές έχουν αναγνωριστεί ως οι πιο σημαντικές αιτίες θνητότητας και νοσηρότητας μετεγχειρητικά σε ασθενείς που υποβάλλονται σε πρωτογενείς ολικές αρθροπλαστικές ισχίου και γόνατος.

Σκοπός: Η καταγραφή των μειζόνων καρδιαγγειακών συμβάντων και της πνευμονικής εμβολής στις πρωτογενείς, προγραμματισμένες, ολικές αρθροπλαστικές ισχίου και γόνατος κατά το έτος 2018 στο Πανεπιστημιακό Γενικό Νοσοκομείο Λάρισας.

Μέθοδος: Στη μελέτη συμπεριλήφθηκαν όλοι οι διαδοχικοί ασθενείς που υποβλήθηκαν σε προγραμματισμένη, πρωτογενή, ετερόπλευρη ΤΗΑ ή ΤΚΑ στη διάρκεια του 2018. Ασθενείς οι οποίοι μετεγχειρητικά εντός 3 μηνών υποβλήθηκαν εκ νέου σε ΤΗΑ ή ΤΚΑ αποκλείστηκαν από τη μελέτη. Καταγράφηκαν τα βασικά δημογραφικά και περιεγχειρητικά χαρακτηριστικά, η θεραπεία με αντιθρομβωτικούς παράγοντες και η περιεγχειρητική διαχείριση της αντιθρομβωτικής αγωγής. Μετεγχειρητικά, έως την έξοδο από το νοσοκομείο ή κατά τη διάρκεια πιθανής επανεισαγωγής καταγράφηκαν τα μείζονα καρδιαγγειακά συμβάντα και η πνευμονική εμβολή.

Αποτελέσματα: Από τους 280 ασθενείς που υποβλήθηκαν σε ΤΗΑ ή ΤΚΑ οι 200 (ΤΗΑ=71, ΤΚΑ=129) πληρούσαν τα κριτήρια εισαγωγής και συμπεριλήφθηκαν στη μελέτη. Οι περισσότεροι από αυτούς ήταν γυναίκες (N=138) με μέση ηλικία τα 69,23 έτη και ASA PS II (N=151). Η μέση διάρκεια της επέμβασης ήταν 90 λεπτά της ώρας και οι 166 ασθενείς έλαβαν υπαραχνοειδή αναισθησία. Συνολικά καταγράφηκαν 5 συμβάντα: πρώτο-εμφανιζόμενη κολπική μαρμαρυγή (N=2), παροξυσμική κολπική μαρμαρυγή

(N=1) και πνευμονική εμβολή (N=2). Δεν καταγράφηκε κανένας θάνατος οφειλόμενος σε καρδιαγγειακά αίτια.

Συμπέρασμα: Οι πρωτογενείς ΤΗΑ και ΤΚΑ αν και είναι σχετικά ασφαλής χαρακτηρίζονται από μικρό ποσοστό απειλητικών για τη ζωή επιπλοκών μετεγχειρητικά όπως τα μείζονα καρδιαγγειακά συμβάντα και η πνευμονική εμβολή.

Λέξεις κλειδιά: ολική αρθροπλαστική, ολική αρθροπλαστική ισχίου, ολική αρθροπλαστική γόνατος, μείζονα καρδιαγγειακά συμβάντα, πνευμονική εμβολή

Abstract

Introduction: Although primary total joint arthroplasty of the hip (THA) and the knee (TKA) are considered to be safe procedures they do carry a small risk of serious life-threatening complications. Major adverse cardiovascular events and thromboembolic complications have been recognized as a significant source of perioperative morbidity and mortality in patients undergoing elective primary THA and TKA.

Aim: Our aim was to identify the major adverse cardiovascular events and the pulmonary embolism in patients undergoing elective primary THA and TKA in the University General Hospital of Larissa during 2018.

Methods: All consecutive patients who underwent elective, primary unilateral THA and TKA during 2018 were included. Patients who were treated with another TKA or THA within three months pre- or post-operatively were excluded. The basic demographic and perioperative characteristics, any previous antithrombotic therapy and the perioperative management of the antithrombotic agents were recorded. Postoperatively, until hospital discharge or during possible hospital readmission, the occurrence of major adverse cardiovascular events and pulmonary embolism were recorded.

Results: From the 280 patients who were screened 200 patients (THA=71, TKA=129) fulfilled the inclusion criteria and were included in our study. Most of them were female (n=138) with an average age of 69,23 years and ASA PS II (n=151). The average duration of operation was 90 minutes and 166 patients received spinal anaesthesia. MACE and PE occurred in 5 patients: 2 patients developed new-onset atrial fibrillation (AF), 1 patient suffered from paroxysmal AF and 2 patients PE. Of note, no cardiovascular mortality was detected.

Conclusion: Although the primary THA and TKA are considered to be relative safe they may lead to life-threatening complications, such as the major adverse cardiovascular events and the thromboembolic complications.

Keywords: total joint arthroplasty, total hip arthroplasty, total knee arthroplasty, major adverse cardiovascular events, pulmonary embolism

Πίνακας Περιεχομένων

1. General Issue

Total hip (THA) and total knee (TKA) arthroplasty are revolutionary and life changing procedures that have upgraded the care of patients who are suffering from end-stage hip and knee arthritis respectively. Both primary THA and TKA are quite common procedures as-based on validated health-related outcome tools - they relieve pain, restore function and increase the mobility of the joint. [1, 2] As a matter of truth, in United States of America (USA) it is estimated that one million patients are treated with THA and TKA every year, hence >7 million patients are living with joint replacements in USA. [1, 2]

It should be noted that THR and TKR are considered to be two of the most clinically successful and cost-effective surgical procedures that have been developed during the last century. [3, 4] Thus, THA was described as "the operation of the century" in *The Lancet*. [3, 4] However, as the implementation of these surgical procedures is increasing, numerous stakeholders tried to evaluate and quantify the outcomes of TKA and THA. As far as the TKA is concerned, the Association of Bone and Joint Surgeons has identified 22 complications (table 1) and adverse events since 2009, including the thromboembolic disease and death (including death from any cardiovascular cause), while some years later, the same organization reported the aforementioned complications in THA (table 2). [3, 4] Although, the overall complication rate for primary elective THA and TKA is low, major complications such VTE and major adverse cardiovascular events (MACE), should be considered as highly debilitating incidents. [2]

The thromboembolic disease, also known as "venous thromboembolism (VTE)", is a well-recognized postoperative complication of total joint arthroplasty. Deep vein thrombosis (DVT) and pulmonary embolism (PE) represent the two clinical conditions that are being included under the term of VTE. [2, 5] Perioperative VTE may lead to increased mortality and morbidity

and increased healthcare cost up to 15.000-30.000$ per incident in patients undergoing THA or TKA. [2, 5] PE after total joint arthroplasty is reported by the Centres for Medicare and Medicaid Services as a "never event", which is a term used to denote "serious and costly medical errors". [6] Regarding the incidence of PE the available data are still conflicting. The reported incidence is highly variable mainly due to the heterogeneity of the sample population, the treatment strategies and the diagnostic paths, with published rates from 1%-2% up to 60%. [5] Besides, when compared to other major surgical operations patients undergoing THA and TKA are at increased risk for VTE, thus the implementation of pharmacological prophylaxis based on the updated guidelines is of outmost importance. [2] However, even healthy patients with no additional risk factors (apart from the total joint arthroplasty procedure) for VTE, who are treated with aggressive anticoagulant regimen, remain at risk for PE development. [6] Hence, PE after THA and TKA continues to represent a significant potential source of perioperative morbidity and mortality.

Moving on to MACE (table 3), it is worth-saying that although they are infrequent after non-cardiac surgery, they are life-threatening complications and they represent the most significant cause of serious perioperative morbidity and mortality. [7] Based on the population studied, the reported incidence varies between 1-7%. [7] According to current literature the reported incidence of MACE in orthopaedic surgery is approximately 2%. Of note, over the last years there have been significant improvements regarding the perioperative cardiovascular care in terms of risk stratification, surgical and anaesthesia techniques and the ongoing research about the optimal perioperative care. However, the rising burden of cardiovascular risk factors in patients undergoing noncardiac surgery, including major orthopaedic surgery such as THA and TKA, may attenuate the improvements in the postoperative care and prognosis over the time. [8–11]

Table 1. Definition of TKA complications and/or adverse events	
Bleeding	Any postoperative hemorrhage that requires intervention
Wound complication	Reoperation or need for a different treatment pathway due to failure of wound healing
Thromboembolic disease	Symptomatic thromboembolic event treated with antithrombotic agents in dose >prophylactic within the first 90 days after the joint arthroplasty
Neural deficit	Postoperative sensory or motor neural deficit related to the joint arthroplasty
Vascular injury	Further surgical intervention, by-pass grafting, or stenting due to intraoperative vascular injury. The development of compartment syndrome or the need for amputation should also be reported.
Medial collateral ligament injury	Medial collateral ligament injury (intraoperatively or early postoperatively) that leads to surgical treatment or a different treatment pathway
Instability	Symptomatic instability, based on the definition by The Knee Society Knee Score, that has been confirmed by laxity on physical examination
Malalignment	Symptomatic malalignment as reported by the patient that is confirmed (x-ray) with angular

Table 1. Definition of TKA complications and/or adverse events	
	deformity (coronal plane >10° from the mechanical axis)
Stiffness	Limited range of motion demonstrated in a physical examination (limited extensions to 15° short of full extension or flexion < 90°) (Not applicable if preoperative arc of motion < 75°)
Deep periprosthetic joint infection	Diagnosis should be made when; • a sinus tract that communicates with the prosthesis is revealed • or a pathogen is isolated by culture sample that was obtained from at least 2 different tissue or fluid samples from the affected prosthetic joint • or 4/6 criteria exist: elevated ESR and serum CRP concentration; elevated synovial WBC count; elevated synovial PMN; presence of purulence in the affected joint; isolation of a microorganism in one culture of periprosthetic tissue or fluid; or > 5 neutrophils/high-power field in 5 high-power fields observed from histologic analysis of periprosthetic tissue at x 400 magnification

Table 1. Definition of TKA complications and/or adverse events	
Periprosthetic fracture	Periprosthetic fracture of the distal femur, proximal tibia, or patella. The treatment plan (operative or nonoperative) should be recorded.
Extensor mechanism disruption	Disruption of the extensor mechanism
Patellofemoral dislocation	Dislocation of the patella from the femoral trochlea
Tibiofemoral dislocation	Dislocation of the tibiofemoral joint
Bearing surface wear	Wear of the bearing surface that is symptomatic or requires surgical intervention
Osteolysis	Expansile lytic lesion adjacent to one of the implants >/= 1 cm in any one dimension or increasing in size on serial radiographs/CT scans
Implant loosening	Identified via x-ray or confirmed via surgery based on a change in the implant position or as a radiolucent line at the bone-cement or bone-implant interface
Implant fracture or tibial insert dissociation	Recorded is mandatory

Table 1. Definition of TKA complications and/or adverse events	
Reoperation	Need for another surgical procedure related to the total joint arthroplasty
Revision	Revision of at least one of the arthroplasty implants
Readmission	Admission to the hospital attributable to any cause within 3 months after the joint replacement
Death	Death attributable to any cause within 3 months after the joint replacement

Table 2. Definition of THA complications and/or adverse events	
Bleeding	Any postoperative hemorrhage that requires intervention
Wound complication	Reoperation or need for a different treatment pathway due to failure of wound healing
Thromboembolic disease	Symptomatic thromboembolic event treated with antithrombotic agents in dose >prophylactic within the first 90 days after the joint arthroplasty
Neural deficit	Postoperative sensory or motor neural deficit related to the joint arthroplasty

Table 2. Definition of THA complications and/or adverse events	
Vascular injury	Further surgical intervention, by-pass grafting, or stenting due to intraoperative vascular injury the occurrence of compartment syndrome or the need for amputation should also be reported
Dislocation/instability	Dislocation of the femoral head out of the acetabulum or recurrent symptomatic subluxation of the hip Any direction of instability along with the type of treatment should be recorded
Periprosthetic fracture	Periprosthetic fracture of the distal femur or the acetabulum The treatment plan (operative or nonoperative) should be recorded
Abductor muscle disruption	New-onset postoperatively symptomatic muscle dysfunction, presented with Trendelenburg sign and the need for an ambulatory assist (cane, crutch, walker) due to weakness or to the treatment of limp (nonoperative treatment should be recorded)
Deep periprosthetic joint infection	Diagnosis should be made when; • a sinus tract that communicates with the prosthesis is revealed • or a pathogen is isolated by culture sample that was obtained from at least 2 different

Table 2. Definition of THA complications and/or adverse events	
	tissue or fluid samples from the affected prosthetic joint or 4/6 criteria exist: elevated ESR and serum CRP concentration; elevated synovial WBC count; elevated synovial PMN; presence of purulence in the affected joint; isolation of a microorganism in one culture of periprosthetic tissue or fluid; or > 5 neutrophils/high-power field in 5 high-power fields observed from histologic analysis of periprosthetic tissue at x 400 magnification
Heterotopic ossification	Symptomatic heterotopic ossification 12 months after surgery with simultaneous stiffness, reduced range of motion, and radiographic grade of Brooker III or IV
Extensor mechanism disruption	Disruption of the extensor mechanism (surgical repair and/or extensor lag should be recorded)
Bearing surface wear	Wear of the bearing surface symptomatic or requiring reoperation
Osteolysis	Expansile lytic lesion adjacent to one of the implants >/= 1 cm in any one dimension or increasing in size on serial radiographs/CT scans
Implant loosening	Identified via x-ray or confirmed via surgery based on a change in the implant position or as

Table 2. Definition of THA complications and/or adverse events	
	a radiolucent line at the bone-cement or bone-implant interface
Cup-liner dissociation	(Acetabular shell)
Implant fracture	Recorded is mandatory
Reoperation	Need for another surgical procedure related to the total joint arthroplasty
Revision	Revision of at least one of the arthroplasty implants
Readmission	Admission to the hospital attributable to any cause within 3 months after the joint replacement
Death	Death attributable to any cause within 3 months after the joint replacement

Table 3. Major adverse cardiovascular events	
Non-fatal cardiac arrest	Absence of cardiac rhythm or presence of chaotic rhythm requiring basic or advanced cardiac life support interventions
Acute myocardial infraction	Increase and gradual decrease in troponin level or a faster increase and decrease of CK-MB in terms of myocardial necrosis accompanied with at least one of the following: symptoms of

Table 3. Major adverse cardiovascular events	
	ischemia, abnormal Q waves, ST-segment elevation or depression; or coronary artery intervention, such as PCI, or a typical decrease in an elevated troponin value (peak levels after the surgical procedure) in a patient without any recorded other reason for the troponin elevation
Congestive cardiac failure	Newly recognized in-hospital dyspnea, orthopnea, paroxysmal nocturnal dyspnea, fatigue, increased jugular venous pressure, pulmonary rales, pulmonary vascular engorgement, cardiomegaly
Cardiac arrhythmia	ECG evidence of AF, AF, 2^{nd} or 3^{rd} degree AV-block
Angina	Dull diffuse substernal chest discomfort, which exaggerates by emotional distress or exertion and subside by bed-rest or nitroglycerin
Stroke	Embolic, thrombotic, or hemorrhagic incident with a duration of at least half-an-hour that may be accompanied by persistent residual motor, sensory, or cognitive dysfunction. Stroke; if the neurological deterioration lasts for > 24 hours Transient ischemic attack; if the neurological deterioration lasts for < 24 hours

Table 3. Major adverse cardiovascular events	
Cardiovascular death	Any death, unless an apparent non-cardiovascular-related cause could be confirmed
Cerebrovascular death	Any death attributable to cerebrovascular disease

2. Special Issue

2.1 Introduction

Major adverse cardiovascular events (MACE) and thromboembolic complications such as pulmonary embolism (PE) after elective primary total joint arthroplasty (TJA) are well-recognized causes of serious morbidity and mortality perioperatively. [9, 10, 12] MACE and PE, prolong inpatient hospitalization, increase medical costs and they have been recognized as significant contributors to perioperative death. [8, 9, 11]

The reported incidence of MACE in patients undergoing elective total hip and total knee arthroplasty (THA, TKA) varies between 1-6.2%, while the incidence of PE is considered to be lower (1-1.5%) respectively. [2, 7–9, 11, 13, 14] THA and TKA are life-saving procedures which may lead to significant improvements in terms of pain, function, mobility and health-related quality of life. [10] However, although elective TJAs are generally safe and common, it should be noted that a significant number of elderly patients with higher comorbidities and prior history of cardiac/thromboembolic disease undergo these procedures annually. [10, 12] Hence, although over the past decades there have been improvements in perioperative care and risk stratification in terms of enhanced recovery and fast-track surgery there is still a risk of serious complications, including MACE and thromboembolic events such as PE, that could adversely affect the outcome and increase the likelihood of long-term disability. [8, 9, 12, 15]

2.2 Aim of the study

The aim of the present study was the registration of the MACE and the PE in patients undergoing elective, unilateral, primary THA and TKA during 2018 in the Orthopaedic department of the University Hospital of Larissa.

2.3 Methods

Data Source

The prospectively collected data from the Department of Orthopaedic Surgery & Musculoskeletal Trauma of the UHL electronic clinical and administrative databases were retrospectively reviewed for this study. The case records were reviewed and the demographic and the perioperative data, along with the outcomes as described below were recorded.

Study design

All consecutive patients age 18 years or older, with a diagnosis of primary osteoarthritis of the hip and knee, who underwent elective, primary, unilateral TKA and THA were included. If a patient had underwent another THA and TKA within three months postoperatively the second procedure was excluded in order to maintain the independence of the observation. Patients who underwent revision surgery or surgical procedures related to a previous complication were also excluded from the study. Exclusion criteria also included: ASA PS IV, a recent history (within 6 months) of unstable acute coronary syndrome or decompensated heart failure.

Operations were performed by the 4 chief arthroplasty surgeons of the department. The time period of interest was from 1 January 2018 to 31 December 2018 and the follow-up was restricted to the postoperative length of hospitalization as this was determined by the treated surgeon. However, the possible hospital readmission due to any of the predefined complications/outcomes was also recorded.

The basic demographic and perioperative characteristics, any previous antithrombotic therapy and the perioperative management of the antithrombotic agents were recorded. Postoperatively, until hospital discharge or during possible hospital readmission, the occurrence of major adverse cardiovascular events and pulmonary embolism were recorded.

Outcomes

Table 3. Major adverse cardiovascular events [7]	
Non-fatal cardiac arrest	Absence of cardiac rhythm or presence of chaotic rhythm requiring basic or advanced cardiac life support interventions
Acute myocardial infraction	Increase and gradual decrease in troponin level or a faster increase and decrease of CK-MB in terms of myocardial necrosis accompanied with at least one of the following: symptoms of ischemia, abnormal Q waves, ST-segment elevation or depression; or coronary artery intervention, such as PCI, or a typical decrease in an elevated troponin value (peak levels after the surgical procedure) in a patient without any recorded other reason for the troponin elevation
Congestive cardiac failure	Newly recognized in-hospital dyspnea, orthopnea, paroxysmal nocturnal dyspnea, fatigue, increased jugular venous pressure, pulmonary rales, pulmonary vascular engorgement, cardiomegaly
Cardiac arrhythmia	ECG evidence of AF, AF, 2^{nd} or 3^{rd} degree AV-block
Angina	Dull diffuse substernal chest discomfort, which exaggerates by emotional distress or exertion and subside by bed-rest or nitroglycerin

Table 3. Major adverse cardiovascular events [7]	
Stroke	Embolic, thrombotic, or hemorrhagic incident with a duration of at least half-an-hour that may be accompanied by persistent residual motor, sensory, or cognitive dysfunction. Stroke; if the neurological deterioration lasts for > 24 hours Transient ischemic attack; if the neurological deterioration lasts for < 24 hours
Cardiovascular death	Any death, unless an apparent non-cardiovascular-related cause could be confirmed
Cerebrovascular death	Any death attributable to cerebrovascular disease

Pulmonary embolism (PE)

- Based on the updated recommendations of the ESC in collaboration with the ERS for the diagnosis of acute pulmonary embolism. [16]

Ethical approval

The study was conducted in accordance with the Ethical Principles for Medical Research Involving Human Subject (Declaration of Helsinki) and was approved by the Scientific Board of the University Hospital of Larissa (36154-20/10/2020). [17] Signed patient concerned was not waived because no care interventions were mandated and no protected health information was collected. Interventions other than routine care were not carried out. The investigators did not modify the customary management of patients.

2.4 Results

Two-hundred and eighty patients underwent elective primary THA and TKA during the study period and were screened for eligibility. Of these 200 patients fulfilled the inclusion criteria and were included in our study (**figure 1**). One-hundred-twenty-nine patients underwent TKA and seventy-one THA. The average age of the patients in our sample was 69,23. THA patients had a lower average age (65,07) when compared to TKA patients (71,53), while the majority of the patients were categorized as ASA physical status II (n= 151/200). **Table 1** shows the demographic characteristic of our patients.

Figure 1. Prisma flowchart

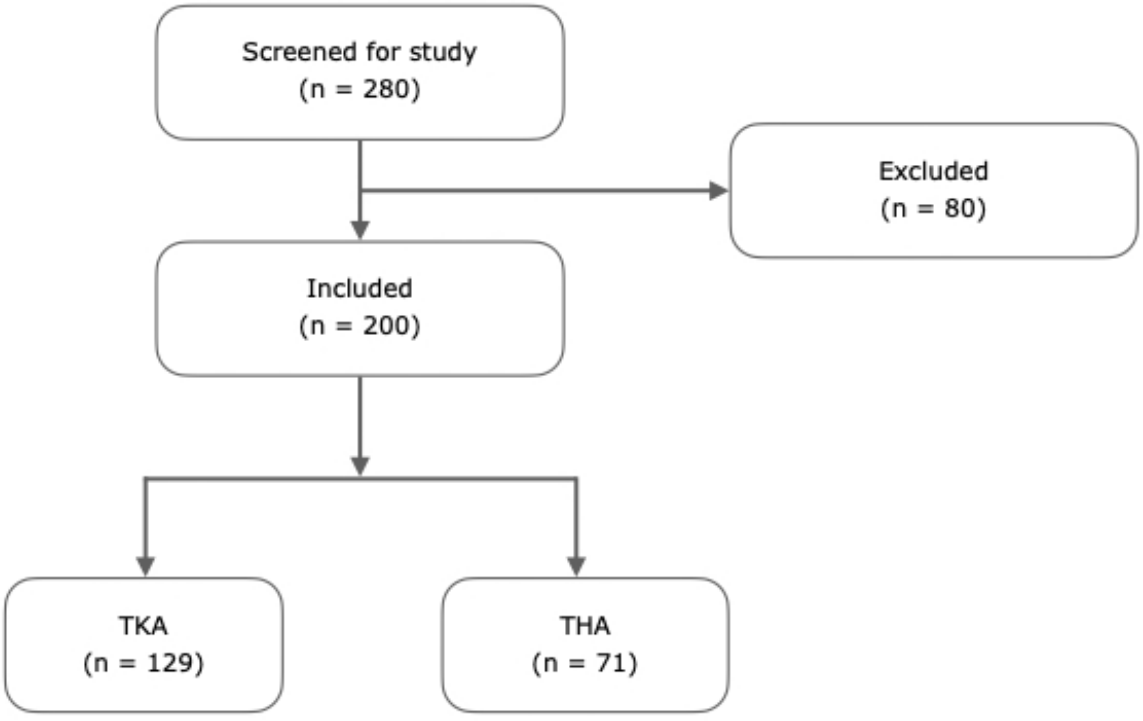


Table 1. Demographic characteristics				
Patient characteristics		**All patients**	**THA patients**	**TKA patients**
Gender	Female	138	47	91
	Male	62	24	38
	Total	200	71	129
Age		69,23 (30 - 85)	65,07 (30 - 84)	71,53 (52 - 86)
BMI		30 (18 - 47)	29,47 (20 - 47)	30,59 (18 - 43)
ASA PS	I	6	6	0
	II	151	54	97
	III	43	11	32

Sixty patients, 42 of the TKA group, were treated with antithrombotic agents (AA) before the planned procedure. Almost half-of them (25/60) were treated with aspirin. The main reason for the antithrombotic therapy was atrial fibrillation in one-third of them (19/60), while the cardiologist was the physician that had prescribed the AA in most of them (33/60), **table 2**.

Table 2. Patients treated with antithrombotic agents before the planned procedure				
		All patients	THA patients	TKA patients
Prior use of AA	Yes	60/200	18/71	42/129
	No	140/200	53/71	87/129
Type of AA	Aspirin	25/60	10/18	15/42
	Clopidogrel	14/60	4/18	10/42

Table 2. Patients treated with antithrombotic agents before the planned procedure				
		All patients	THA patients	TKA patients
	DAPT	2/60	0/18	4/42
	Acenocumarol	5/60	0/18	2/42
	Combined antiplatelet + anticoagulant	1/60	1/18	0/42
	Dabigatran	4/60	1/18	3/42
	Rivaroxaban	5/60	2/18	3/42
	Apixaban	4/60	0/18	5/42
Reason for AA	Unknown	12/60	5/18	8/42
	PLTs disorders	2/60	1/18	1/42
	Atrial Fibrillation	19/60	4/18	15/42
	Coronary artery disease	14/60	4/18	10/42
	Coronary artery disease + stent	1/60	1/18	0/42
	Previous myocardial infraction	1/60	0/18	1/42
	Iliac artery stent	1/60	0/18	1/42

Table 2. Patients treated with antithrombotic agents before the planned procedure				
		All patients	THA patients	TKA patients
	Stroke	1/60	1/18	0/42
	Transient Ischemic Attach	2/60	1/18	1/42
	Carotid artery stenosis	5/60	1/18	4/42
	Aortic Valve replacement	1/60	0/18	1/42
	Congestive Heart Failure	1/60	0/18	1/42
Doctor who prescribed the AA	Unknown	22/60	11/18	11/42
	Cardiologist	33/60	7/18	26/42
	Neurologist	1/60	0/18	1/42
	Vascular surgeon	4/60	0/18	4/42

Table 3 presents the main information about the management of the AA perioperatively in patients that were treated with antithrombotics before the planned procedure.

Table 3. Perioperative management of antithrombotic agents in patients treated with antithrombotic agents before the planned procedure				
		All patients	THA patients	TKA patients
Perioperative discontinuation of AA	Yes	59/60	18/18	41/42
	No	1/60	0/18	1/42
Duration of discontinuation (days)		6,87 (3 - 30)	7,58 (3 - 30)	6,57 (3 - 11)
Perioperative replacement of AA	No replacement	36/59	13/18	23/42
	Bemiparin	3/59	2/18	1/42
	Enoxaparin	6/59	0/18	6/42
	Tinzaparin	12/59	3/18	9/42
	Fraxiparin	2/59	0/18	2/42
Dose of LMWH	Prophylactic	18/23	4/5	14/18
	Intermediate	2/23	0/5	2/18
	Therapeutic	3/23	1/5	2/18
Doctor who gave instructions for the pre-op discontinuation of the AA	unknown	55/60	18/18	37/42

Table 3. Perioperative management of antithrombotic agents in patients treated with antithrombotic agents before the planned procedure				
		All patients	THA patients	TKA patients
	Cardiologist	5/60	0	5/42
First dose of LMWH (post-op hours)		11,75 (8 - 38)	11,29 (8 - 16)	12,00 (8 - 38)
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon	60/60	18/18	42/42
Re-initiation of the AA	Unknown	34/59	13/18	21/42
	Days for the rest patients (25/59)	10,12 (2 - 36)	11 (2 - 30)	9,9 (2 - 36)

Table 4 depicts the basic perioperative information of our study sample. The vast majority of our patients underwent the planned procedure under spinal anesthesia. The average duration of operation was 90 minutes, while the average TKA duration was longer when compared to THA (93,10 vs 83,94 minutes). Only 41/200 patients received tranexamic acid intravenously perioperatively, most of them 1000mg (38/41).

Table 4. Perioperative information				
		All patients	**THA patients**	**TKA patients**
Type of anaesthesia	Spinal	166/200	65/71	101/129
	Combined (spinal/epidural)	23/200	1/71	22/129
	General	11/200	5/71	6/129
Duration of operation		90 (45 – 180)	83,94 (45 - 180)	93,10 (50 - 130)
Peri-op iv use of tranexamic acid	Yes	41/200	19/71	22/129
	No	159/200	52/71	107/129
Tranexamic acid </= 1000mg		38/41	19/19	19/22
Tranexamic acid 1000mg 2000mg		3/41	0/19	3/22
Tranexamic acid >/= 3000 mg		0/41	0/19	0/22
Pre-op Hb		13,35	13,56	13,23
Intra-op Hb		12,19	11,35	12,65

Table 4. Perioperative information				
		All patients	**THA patients**	**TKA patients**
First post-op day Hb		11,05	10,65	11,27
Redon placement	Yes	60/200	15/71	45/129
	No	137/200	56/71	81/129
	Unknown	3/200	0/71	3/129
First post-op day redon volume (mL)	<500	42/60	13/15	29/45
	>500	18/60	2/15	16/45
Transfusion	Yes	20/200	13/71	7/129
	No	180/200	58/71	122/129
Transfusion, units of RBCs	1	20/200	13/13	7/7
	2	0/200	0/13	0/7
Postoperative thrombo-prophylaxis	Bemiparin	116/200	41/71	75/129
	Enoxaparin	3/200	0/71	3/129
	Tinzaparin	77/200	29/71	48/129
	Fraxiparin	4/200	1/71	3/129

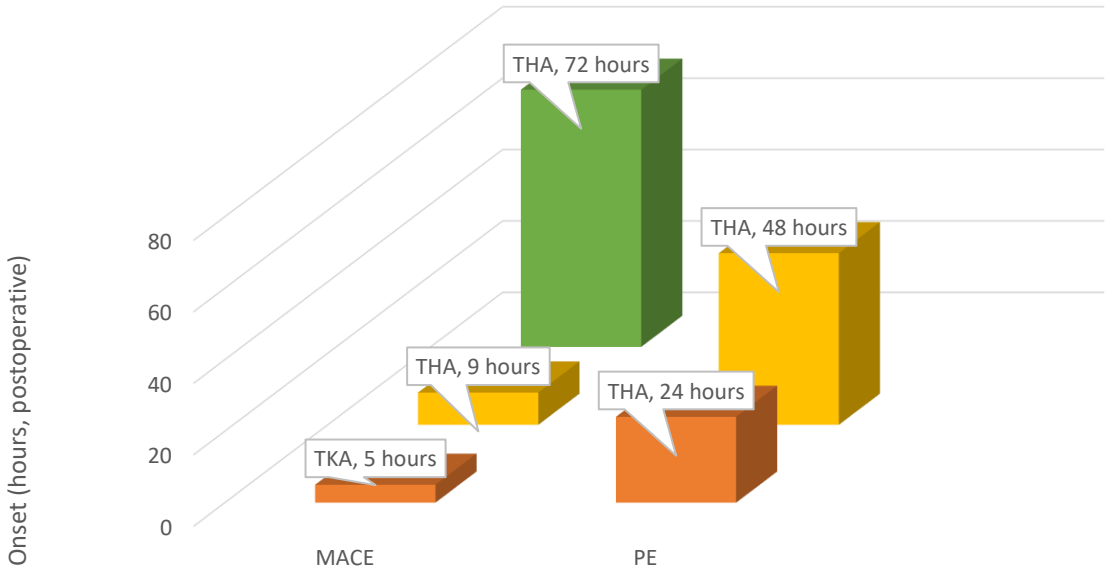
Table 4. Perioperative information				
		All patients	**THA patients**	**TKA patients**
LOS (days)		7,15 (3 - 51)	8,45 (3 – 51)	6,47 (4 – 18)

Of note all of our study sample patients postoperatively were treated with LMWH in prophylactic dose in terms of thromboprophylaxis (table 4). Most of them (116/200) received bemiparin, fewer (77/200) tinzaparin and only 4 and 3 patients received fraxiparin and enoxaparin respectively.

MACE and PE occurred in 5 patients: 2 patients developed new-onset atrial fibrillation (AF), 1 patient suffered from paroxysmal AF and 2 patients PE (**table 5**). However, it should be noted that none of the patients suffered from non-fatal cardiac arrest, acute myocardial infraction, congestive cardiac failure, angina, stroke, cardiovascular or cerebrovascular death. Moreover, all the aforementioned complications happened during the immediate, within 12 hours, or the early post-operative period, 1st – 3rd postoperative day (**figure 2**). All the patients were discharged alive from the hospital without any permanent deficit.

Table 5. Outcomes			
Outcome	**All patients**	**THA patients**	**TKA patients**
MACE and PE	2,5% (n=5/200)	5,632% (n=4/71)	0,77% (n=1/129)
MACE	1,5% (n=3/200)	2,816% (n=2/71)	0,77% (n=1/129)
PE	1,0% (n=2/200)	2,816% (n=2/71)	0% (n=0)

Figure 2. Time of onset of MACE and PE (postoperatively)



The basic demographic characteristics of the patients that suffered from MACE and PE are outlined in **table 6**.

Table 6. Demographic characteristics of patients suffering from major adverse cardiovascular events and pulmonary embolism

Patient characteristics		All patients	THA patients	TKA patients
Gender	Female	3	2	1
	Male	2	2	0
	Total	5	4	1
Age		75, 6 (71 - 79)	76 (71 - 79)	74
BMI		35 (33 – 37)	35 (33 - 37)	36
ASA PS	I	0	0	0
	II	3	2	1
	III	2	2	0

Three of the patients that were suffered from MACE and PE postoperatively were treated with antithrombotic agents (AA) before the planned procedure, **table 7**.

Table 7. Patients suffered from MACE and PE that were treated with antithrombotic agents before the planned procedure

		All patients	THA patients	TKA patients
Prior use of AA	Yes	3/5	2/4	1/1
	No	2/5	2/4	0/1
Type of AA	Aspirin	2/3	1/2	1/1
	Clopidogrel	0/3	0/2	0/1
	DAPT	0/3	0/2	0/1
	Acenocumarol	0/3	0/2	0/1
	Combined ATP + ATC	0/3	0/2	0/1
	Dabigatran	1/3	1/2	0/1
	Rivaroxaban	0/3	0/2	0/1
	Apixaban	0/3	0/2	0/1
Reason for AA	Unknown	1/3	1/2	1/1
	PLTs disorders	0/3	0/3	0/1
	AF	1/3	1/2	0/1
	CAD	1/3	1/2	0/1
	CAD + stent	0/3	0/3	0/1

Table 7. Patients suffered from MACE and PE that were treated with antithrombotic agents before the planned procedure				
		All patients	THA patients	TKA patients
	MI (CAD)	0/3	0/3	0/1
	Iliac artery stent	0/3	0/3	0/1
	Stroke	0/3	0/3	0/1
	TIA	0/3	0/3	0/1
	Carotid artery stenosis	0/3	0/3	0/1
	AoVR	0/3	0/3	0/1
	CHF	0/3	0/3	0/1
Doctor who prescribed the AA	Unknown	1/3	11/18	1/1
	Cardiologist	2/3	2/2	0/1
	Neurologist	0/3	0/2	0/1
	Vascular surgeon	0/3	0/2	0/1

Table 8 presents the main information about the management of the AA perioperatively in patients that suffered from MACE and PE that were treated with antithrombotics before the planned procedure.

Table 8. Perioperative management of the AA perioperatively in patients that suffered from MACE and PE and were treated with antithrombotics before the planned procedure				
		All patients	THA patients	TKA patients
Perioperative discontinuation of AA	Yes	3/5	2/2	1/1
	No	2/5	0/2	0/1
Duration of discontinuation (days)		4,66 (3-8)	3	8
Perioperative replacement of AA	No replacement	3/5	2/2	1/1
	Bemiparin	0/5	0/2	0/1
	Enoxaparin	0/5	0/2	0/1
	Tinzaparin	0/5	0/2	0/1
	Fraxiparin	0/5	0/2	0/1
Dose of LMWH	Prophylactic	0/5	0/2	0/1
	Intermediate	0/5	0/2	0/1
	Therapeutic	0/5	0/2	0/1
Doctor who gave instructions for the pre-op discontinuation of the AA	unknown	3/3	2/2	1/1

Table 8. Perioperative management of the AA perioperatively in patients that suffered from MACE and PE and were treated with antithrombotics before the planned procedure				
		All patients	THA patients	TKA patients
	Cardiologist	0/3	0/2	0/1
First dose of LMWH (post-op hours) as thromboprophylaxis		10,8 (9-14)	11,25 (10-14)	9
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon	3/3	2/2	1/1
Re-initiation of the AA	Unknown	2/3	1/2	1/1
	Days for the rest patients (1/3)	2	2	9,9 (2-36)

Table 9 depicts the basic perioperative information of our study sample. The vast majority of our patients underwent the planned procedure under spinal anesthesia. The average duration of operation was 110 minutes, which is longer compared to the duration of the operation of the rest of the patients (89,56 minutes).

Tables 10 - 14 present the basic information about the patients that suffered from MACE and PE and the course of the MACE and PE.

Table 9. Perioperative information of patients that suffered from MACE and PE				
		All patients	**THA patients**	**TKA patients**
Type of anaesthesia	Spinal	5/5	4/4	1/1
	Combined (spinal/epidural)	0/5	0/4	0/1
	General	0/5	0/4	0/1
Duration of operation		101 (70 – 150)	83,94 (45-180)	85
Peri-op iv use of tranexamic acid	Yes	0/5	0/4	0/1
	No	5/5	4/4	1/1
Tranexamic acid </= 1000mg		0/5	0/4	0/1
Tranexamic acid 1000mg 2000mg		0/5	0/4	0/1
Tranexamic acid >/= 3000 mg		0/5	0/4	0/1
Pre-op Hb		11,98	12,07	11,6
Intra-op Hb		10,72	10,75	10,6
First day Hb		9,76	9,95	9

Table 9. Perioperative information of patients that suffered from MACE and PE				
		All patients	**THA patients**	**TKA patients**
Redon placement	yes	0/5	0/4	0/1
	no	5/5	4/4	1/1
	unknown	0/5	0/4	0/1
First day redon volume (mL)	<500	0/5	0/4	0/1
	>500	0/5	0/4	0/1
Transfusion	Yes	3/5	2/4	1/1
	No	3/5	2/4	0/1
Transfusion, units of RBCs	1	3/3	2/3	1/1
	2	0/3	0/3	0/1
	5	1/3	1/3	0/1
Postoperative thrombo-prophylaxis	Bemiparin	3/5	3/4	0/1
	Enoxaparin	0/5	0/3	0/1
	Tinzaparin	1/5	1/4	0/1
	Fraxiparin	1/5	0/4	1/1
LOS (days)		10,60 (7 - 18)	11,5 (7 – 18)	7

Table 10A. Patient characteristic that underwent TKA and suffered from MACE

Gender	Female
Age	74
BMI	36
ASA PS	II
Comorbidities	Hypertension Hypercholesterolemia GERD
Prior use of AA	Aspirin
Reason for AA	Unknown
Doctor who prescribed the AA	Unknown
Perioperative discontinuation of AA	Yes
Duration of discontinuation (days)	8
Perioperative replacement of AA	No replacement
Doctor who gave instructions for the pre-op discontinuation	Unknown
First dose of LMWH (post-op hours) as thromboprophylaxis	9
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	Unknown

Table 10B. Perioperative information of patient that underwent TKA and suffered from MACE

Type of anaesthesia	Spinal
Duration of operation	85
Peri-op iv use of tranexamic acid	No
Pre-op Hb	11,6
Intra-op Hb	10,6
First day Hb	9
Redon placement	No
Transfusion	Yes
Transfusion, units of RBCs	1
Postoperative thrombo-prophylaxis	Fraxiparin
First dose of LMWH (post-op hours) as thromboprophylaxis	9
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	Unknown

Table 10C. Perioperative information of patient that underwent TKA and suffered from MACE

Type of MACE	AF (first episode), 135 bpm, without cardiovascular compromisation (135/95 mmHg)
Presentation postoperatively (hours)	5
Diagnosis	12-lead ECG
Initial therapy	Amiodarone 300 mg bolus (30 minutes) Amiodarone infusion 12 hours
Duration of MACE (hours)	16
Long-term therapy	b-blocker (1st post-op day) Rivaroxaban (4th post-op day)
Discharge	Alive (6th post-op day)
Total LOS (days)	7

Table 11A. Patient characteristic that underwent THA and suffered from MACE (1)

Gender	Female
Age	78
BMI	33
ASA PS	III
Comorbidities	Coronary Artery Disease, Hypertension, Hypercholesterolemia Hypothyroidism, Depression, Osteoporosis
Prior use of AA	Aspirin
Reason for AA	Coronary Artery Disease
Doctor who prescribed the AA	Cardiologist
Perioperative discontinuation of AA	Yes
Duration of discontinuation (days)	3
Perioperative replacement of AA	No replacement
Doctor who gave instructions for the pre-op discontinuation	Unknown
First dose of LMWH (post-op hours) as thromboprophylaxis	10
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	Unknown

Table 11B. Perioperative information of patient that underwent THA and suffered from MACE (1)

Type of anaesthesia	Spinal
Duration of operation	85
Peri-op iv use of tranexamic acid	No
Pre-op Hb	11,1
Intra-op Hb	9,6
First day Hb	9,5
Redon placement	No
Transfusion	No
Transfusion, units of RBCs	-
Postoperative thrombo-prophylaxis	Bemiparin
First dose of LMWH (post-op hours) as thromboprophylaxis	10
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	Unknown

Table 11C. Perioperative information of patient that underwent THA and suffered from MACE (1)

Type of MACE	AF (first episode), 196 bpm, with slight cardiovascular compromisation (93/66 mmHg)
Presentation postoperatively (hours)	9 hours
Diagnosis	12-lead ECG
Initial therapy	Digoxin 0.5 mg 100 ml normal saline 20 minutes Amiodarone 300 mg bolus (30 minutes) Amiodarone infusion 12 hours
Duration of MACE (hours)	6
Long-term therapy	Amiodarone p.os. (4^{th} post-op day) Rivaroxaban (6^{th} post-op day) Continuation of pre-op b-blocker therapy (bisoprolol)
Discharge	Alive (6^{th} post-op day)
Total LOS (days)	7

Table 12A. Patient characteristic that underwent THA and suffered from MACE (2)

Gender	Male
Age	79
BMI	35
ASA PS	II
Comorbidities	Hypertension, Hypercholesterolemia Diabetes mellitus (diet treatment)
Prior use of AA	No
Reason for AA	Not applicable
Doctor who prescribed the AA	Not applicable
Perioperative discontinuation of AA	Not applicable
Duration of discontinuation (days)	Not applicable
Perioperative replacement of AA	Not applicable
Doctor who gave instructions for the pre-op discontinuation	Not applicable
First dose of LMWH (post-op hours) as thromboprophylaxis	14
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	Not applicable

Table 12B. Perioperative information of patient that underwent THA and suffered from MACE (2)

Type of anaesthesia	Spinal
Duration of operation	115
Peri-op iv use of tranexamic acid	No
Pre-op Hb	11,5
Intra-op Hb	11,4
First day Hb	11,1
Redon placement	No
Transfusion	No
Transfusion, units of RBCs	-
Postoperative thrombo-prophylaxis	Bemiparin
First dose of LMWH (post-op hours) as thromboprophylaxis	10
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	Unknown

Table 12C. Perioperative information of patient that underwent THA and suffered from MACE (2)

Type of MACE	AF (first episode), 110 bpm, without cardiovascular compromisation (110/80 mmHg)
Presentation postoperatively (day)	3rd post-op day
Diagnosis	12-lead ECG
Initial therapy	Amiodarone 300 mg bolus (30 minutes) Amiodarone infusion 12 hours
Duration of MACE (hours)	6
Long-term therapy	Amiodarone p.os. (5th post-op day) Initiation of b-blocker therapy (labetalol, 5th post-op day) Recommendation for Holter
Discharge	Alive (12th post-op day)
Total LOS (days)	13

Table 13A. Patient characteristic that underwent THA and suffered from PE (1)

Gender	Male
Age	71
BMI	34
ASA PS	III
Comorbidities	Hypertension, Hypercholesterolemia, Atrial fibrillation, Coronary artery disease (possibly?) Cerebrovascular disease (possibly?)
Prior use of AA	Dabigatran
Reason for AA	Atrial fibrillation
Doctor who prescribed the AA	Cardiologist
Perioperative discontinuation of AA	Yes
Duration of discontinuation (days)	3
Perioperative replacement of AA	No
Doctor who gave instructions for the pre-op discontinuation	Unknown
First dose of LMWH (post-op hours) as thromboprophylaxis	11
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	2nd post-op day

Table 13B. Perioperative information of patient that underwent THA and suffered from PE (1)

Type of anaesthesia	Spinal
Duration of operation	70
Peri-op iv use of tranexamic acid	No
Pre-op Hb	12,3
Intra-op Hb	9,9
First day Hb	8,3
Redon placement	No
Transfusion	Yes
Transfusion, units of RBCs	1
Postoperative thrombo-prophylaxis	Tinzaparin
First dose of LMWH (post-op hours) as thromboprophylaxis	11
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	2nd post-op day

Table 13C. Perioperative information of patient that underwent THA and suffered from PE (1)

Type of MACE	Pulmonary embolism Hypoxia (79% SpO_2), Respiratory failure
Presentation postoperatively (days)	2nd post-op day
Diagnosis	CTPA
Initial therapy	Continuation of dabigatran Salbutamol Oxygen
Long-term therapy	Dabigatran
Discharge	Alive (6th post-op day)
Total LOS (days)	8

Table 14A. Patient characteristic that underwent THA and suffered from PE (2)

Gender	Female
Age	76
BMI	37
ASA PS	II
Comorbidities	Hypertension, Hyperuchemia
Prior use of AA	No
Reason for AA	Not applicable
Doctor who prescribed the AA	Not applicable
Perioperative discontinuation of AA	Not applicable
Duration of discontinuation (days)	Not applicable
Perioperative replacement of AA	Not applicable
Doctor who gave instructions for the pre-op discontinuation	Not applicable
First dose of LMWH (post-op hours) as thromboprophylaxis	10
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	Not applicable

Table 14B. Perioperative information of patient that underwent THA and suffered from PE (2)

Type of anaesthesia	Spinal
Duration of operation	150
Peri-op iv use of tranexamic acid	No
Pre-op Hb	13,4
Intra-op Hb	12,1
First day Hb	10,9
Redon placement	No
Transfusion	Yes
Transfusion, units of RBCs	5
Postoperative thrombo-prophylaxis	Bemiparin
First dose of LMWH (post-op hours) as thromboprophylaxis	10
Doctor who gave instructions for the post-op initiation of the LMWH	Surgeon
Re-initiation of the AA	Not applicable

Table 14C. Perioperative information of patient that underwent THA and suffered from PE (2)

Type of MACE	Pulmonary embolism Hypoxia (82% SpO_2, lowest)
Presentation postoperatively (days)	1st post-op day
Diagnosis	CTPA (3rd post-op day)
Initial therapy	Fraxiparin (treatment dose) Salbutamol Oxygen
Long-term therapy	Fraxiparin (prophylactic dose dose)
Discharge	Alive (17th post-op day)
Total LOS (days)	18

2.5 Discussion

In this study we found that the overall rate of MACE and PE in patients undergoing elective, unilateral THA and TKA is 2.5% (THA; 5,632%, TKA; 0,77%). The rate of MACE and PE in THA was found to be 2,816% for both the complications, while the rate of MACE in patients undergoing TKA was 0,77%. None of the patients undergoing TKA suffered from PE.

The results of our study are in accordance with the current literature and the updated available guidelines.[2, 8, 12, 14, 18, 19] As far as the risk of MACE is concerned, based on both the European [18] and the American [8] updated guidelines regarding the perioperative cardiovascular risk for noncardiac surgery "the 30-day risk of cardiovascular death and myocardial infraction that takes account only the specific surgical intervention, without considering the patient's comorbidities" is estimated to be 1-5% for major orthopaedic surgery, while "the level of risk for mace or death is >/=1%" for the orthopaedic procedures respectively. [8, 18]

Moreover, it should be noted that none of our patients suffered from acute myocardial infraction or cardiovascular death. As reported by Smilowitz et all, in the most recent and largest multicentred-study, in which the largest proportion of the patients included (40.2%) underwent orthopaedic procedures regarding the perioperative MACE in patients undergoing non-cardiac surgery, there has been an encouraging reduction in acute myocardial infraction and cardiovascular death. [11] The authors concluded that the encouraging reduction in the rates of acute myocardial infraction and cardiovascular death may be attributable to the improved pharmacologic and percutaneous strategies in the management of coronary artery disease along with the recognition of the increased perioperative thrombotic risk early after the incidence of any acute coronary event and the postponement of any non-urgent surgical procedure as indicated by the available guidelines. [11, 18]

As far as the pulmonary embolism is concerned in patients undergoing hip and knee arthroplasty the incidence varies between 0.6-1.5%.[2, 12] The overall incidence of PE in our cohort was found to be 1%, which is in accordance to the available literature. [2, 10, 12] However, the data regarding the differences in the rate of PE between the two types of lower limb arthroplasty (THA vs TKA) are still conflicting [2, 6, 10, 12, 13, 15, 19–22]. In our study none of the TKA patient developed PE and 2/71 (2.816%) THA patients developed PE. Although TKA is considered to be more thrombogenic and most studies traditionally have reported a higher incidence of PE in TKA patients, when compared to THA, current evidences suggest a decrease in the DVT rate. [2, 6, 10–13, 20] Hence, our results are in accordance with the studies by Singh et all and Xing et all, who indicated that THA patients have a higher risk for VTE for a longer period. [2, 10, 23]

Furthermore, it should be highlighted that both the patients that suffered from PE were obese. The BMI of the first patients was 34 (obese class I), while our second patient was classified as obese class II (BMI 37). Based on the results of Sloan et all [21] the rate of PE that may result in treatment within the first 30 postoperative days is associated with class I obesity or higher among patients undergoing THA. Additionally, as female gender may be protective in TKA patients in terms of postoperative complications, the slightly higher percentage of female patients in the TKA cohort (TKA=71% vs THA=66%) group could be a possible explanation for the higher incidence of PE in the THA group of our sample. [20]

The results of our study should be interpreted in the light of limitations that are presented below. This is a retrospective analysis, from a single centre, with a relatively small size of participants. However, all the data were acquired prospectively and we screened all the patients that underwent THA and TKA during one year in our department and the all the patients that fulfilled the predefined inclusion criteria formed our study sample. Moreover, we did not

exclude the patients that were suffering from atrial fibrillation or stable coronary artery disease, as several previous studies did in terms of confounding factors, in an attempt to register the rate of MACE and PE based on a more thorough strategy. Lastly, the vast majority of patients were female and the largest percentage of our sample was composed from TKA patients, hence our results cannot represent the general population.

2.6 Conclusions

In our study cohort the overall rate of MACE and PE was 2.5% and THA patients experienced a higher rate of both MACE and PE. None of our patients suffered from cardiovascular death or massive PE and none of TKA patients from PE. As MACE and PE remain a major source of morbidity and mortality after THA and TKA, although both operations are considered to be relative safe, ongoing efforts seem mandatory for the optimal perioperative care of these patients, the avoidance of predictable complications and the increased postoperative safety.

2.7 References

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