Kardiologia Polska 2017; 75, 8: 729–735; DOI: 10.5603/KP.2017.0151 ISSN 0022–9032

ARTYKUŁ SPECJALNY / *STATE-OF-THE-ART REVIEW*

Cardioorthopedics — is it necessary in clinical practice? A study of patients with hip replacement surgery

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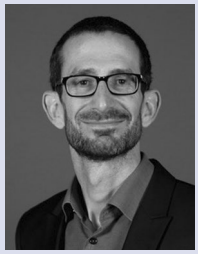

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Received: 27.03.2017 **Accepted:** 29.03.2017

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INTRODUCTION

It is increasingly common in orthopaedic practice to be faced with patients with both multiple comorbidities and polypharmacy. Therefore, knowledge of possible drug and disease interactions is increasingly important for those assessing the fitness of such patients for surgery, in both the elective and emergency setting.

Among all non-communicable diseases, cardiovascular disease (CVD) is the leading cause of death worldwide [1]. It is estimated that in Europe, CVD accounts for nearly half of all deaths [2]. Therefore, cardiovascular risk factors must be taken into account when planning surgery. Recently published guidelines from the European Society of Cardiology (ESC) for the perioperative management of patients undergoing non-cardiac surgery provide useful data and help to organise management in many groups of patients [3]. Guidelines indicate that the perioperative risk of complications is related to the incidence of comorbidities before surgery, as well as the urgency, extent, type, and duration of surgery. Cardiac complications can occur particularly in patients with documented or asymptomatic ischaemic heart disease, left ventricular dysfunction, valvular heart disease, and cardiac arrhythmias, who undergo surgical procedures associated with prolonged haemodynamic load and strain on the heart. However, these guidelines do not contain sufficient information on how patients undergoing individual types of procedures, especially orthopaedic procedures, should be dealt with. Orthopaedic surgeries are often a great challenge and are a huge burden for patients, especially the elderly with multiple comorbidities. Therefore, a multidisciplinary approach combining orthopaedic surgeons and cardiologists is extremely important in ensuring patient safety in the perioperative period.

HIP SURGERY IN THE MODERN WORLD

Altogether, the annual number of major operations is calculated to include about 4% of the world population [4]. Assuming that the frequency of such operations is the same in Europe, where the total population exceeds 500 million people, the estimated number of major operations is around 19 million per year. Probably, many of these operations are performed in patients with low cardiovascular risk; however, ESC data show that 30% of patients undergoing surgery have concomitant CVD [3]. This means that there are 5.7 million operations of this type every year. These surgeries are associated with high complication rates — an average of 7–11% per annum, and mortality 0.8–1.5% [5]. More importantly, 42% of these problems are caused by cardiovascular complications [6].

Currently, one of the most frequently performed types of surgery is orthopaedic surgery, especially joint arthroplasty of hip or knee. Hip replacements were developed in the 1960s. They constituted a major breakthrough in orthopaedic surgery. Today, after many years of development, it has become one of the most successful operations for improving quality of life.

Complications following total hip replacement are quite rare. However, due to the increasing number of surgical procedures and the relatively high average age of the patients, the overall numbers of complications are increasing. During the first 5–9 years, patients after arthroplasty are at lower cardiovascular mortality risk compared with the control cohort. However, the risk in the arthroplasty cohort increases over time and is higher than in the general population after 8.8 years [7].

Some important complications of hip and knee replacement are:

- venous thromboembolism;
- pulmonary embolism;
- infection of the operated joint;
- complications of transfusion.

Surgeries in the field of hip and knee replacement are recognised interventions effectively limiting severe pain in patients with advanced degenerative changes in the joints. Epidemiological studies suggest that there is a constantly increasing demand for this type of treatment [8]. It is estimated that in the United States of America in 2030 there will be a 673% increase in the number of hip replacement procedures and a 174% increase in knee replacements [8]. Currently, there are about 320 centres in Poland performing endoprosthetic surgery. According to data provided by the National Health Fund, in 2015, 46,685 hip joint replacements were performed, of

which 37,126 were total endoprosthesis, 8898 were partial endoprosthesis, and 661 were repair procedures. The majority of patients were elderly people aged 60–69 years. Primary hip replacement surgery was performed in patients aged 6–106 years; in 50% of cases, the age of the patient was less than 69 years [9]. Orthopaedic surgeries concerning the knee and hip joints are interventions with respectively low (< 1%), and intermediate (1–5%) risk of sudden death or a myocardial infarction within 30 days after treatment, but certain patients may be at high risk [10]. Patients undergoing this surgery are usually elderly with restricted physical activity because of pain in the joints, and as a result are at increased risk of CVD. Moreover, quoting one of the authors of a recent review on this subject "hip fracture is one of the most common orthopaedic conditions that requires hospital admission and is associated with significant morbidity and mortality". The annual incidence of hip fracture was estimated to be 1.66 million worldwide in 1990 and is expected to reach 6.26 million by 2050 due to the aging population [11]. The majority of hip fractures occur in geriatric patients: approximately 80% of women and 50% of men with hip fractures are aged ≥ 70 years [12].

THE IMPORTANCE OF CARDIOVASCULAR RISK IN ORTHOPAEDIC PATIENTS

Cardiovascular disease causes more than 4 million deaths a year in Europe, which represents 45% of the total number of deaths. In 2015, ischaemic heart disease and cerebrovascular disease were the most common causes of cardiovascular death, accounting for 1.8 million and 1.0 million deaths, respectively. The number of deaths from CVD in recent years has been higher in women (2.2 million) than in men (1.8 million), accounting for 49% of all deaths among women and 40% of all deaths in men. Statistical data show that in this group, the total number of deaths from coronary heart disease is similar among men and women, and the differences between the sexes stem from a greater number of women dying from cerebrovascular disease and other diseases of the cardiovascular system [13].

Early identification of the factors responsible for the development of CVD cannot only effectively prevent the occurrence of CVD, but also afford better control of disease and potential resolution. One of the first large-scale studies to identify risk factors for CVD was the Framingham Heart Study.

In 1948 the Framingham Heart Study was initiated under the direction of the National Heart Institute (now known as the National Heart, Lung, and Blood Institute, or NHLBI) — an ambitious medical research project, which has changed the face of medicine. At the time, little was known about the general causes of heart disease and stroke, but mortality from CVD has been continuously growing since the beginning of the 19th century and has gradually taken on an epidemic scale [14]. Over the years, careful monitoring of the population of Framingham study led to the identification of the main risk factors for diseases of the cardiovascular system such as — high blood pressure, high blood cholesterol, smoking, obesity, diabetes, and physical inactivity. It has also provided valuable information on the impact on CVD associated factors, such as triglycerides or low-density lipoprotein-cholesterol, age, gender, and psychosocial issues. In the last half century, the study resulted in the publication of about 1200 articles in leading medical journals. The concept of identification of risk factors for CVD is now an integral part of a modern medical programme, which has led to the development of effective strategies for the treatment and prevention commonly used in clinical practice. The Framingham Heart Study continues to have a significant impact on the scientific world by increasing diagnostic capabilities based on research outcomes. New diagnostic technologies, such as echocardiography, carotid ultrasound, magnetic resonance imaging of the heart and brain, computed tomography of the heart, and bone densitometry, were included in past and current research protocols.

The factors of cardiovascular risk described above were recently evaluated in a prospective study of patients treated with joint arthroplasty. The Cardiovascular Risk Assessment ScHeme in JOINT arthroplasty study (CRASH-JOINT) revealed the relatively high prevalence of both classical as well as non-classical cardiovascular risk factors in patients undergoing total hip or knee replacement, and showed that those factors are more common than in the general population [15]. In the study, we found that out of 98 patients, eight patients were excluded from the study and surgery, mainly due to cardiac causes. The mean age of the study population was 63.7 ± 12.2 years, and 62.2% were females. Fifty (55.6%) patients were diagnosed with arterial hypertension in the past, ten (11.1%) patients had diabetes mellitus, two (2.2%) had a history of myocardial infarction, and family history of CVD was present in 24 (26.7%) cases. Mean body mass index (BMI) was 28.0 ± 5.1 kg/m^2 and 39 (43.3%) patients were overweight, while 28 (31.1%) were obese. These findings are consistent with others presented in epidemiological papers (Fig. 1).

METHODS FOR CARDIOVASCULAR RISK EVALUATION

Cardiovascular assessment is crucial when taking care of patients in the orthopaedic department in order to avoid complications. As was mentioned previously [15], the occurrence of cardiac complications after surgery depends on the risk factors of the patient and the type of operation [16]. Each operation triggers a stress response that is initiated by tissue damage, developed with the participation of neuroendocrine factors, and may cause a sympathetic imbalance resulting in myocardial oxygen consumption increase, and an imbalance between prothrombotic factors and fibrinolytic factors. Factors such as duration of the procedure, position of

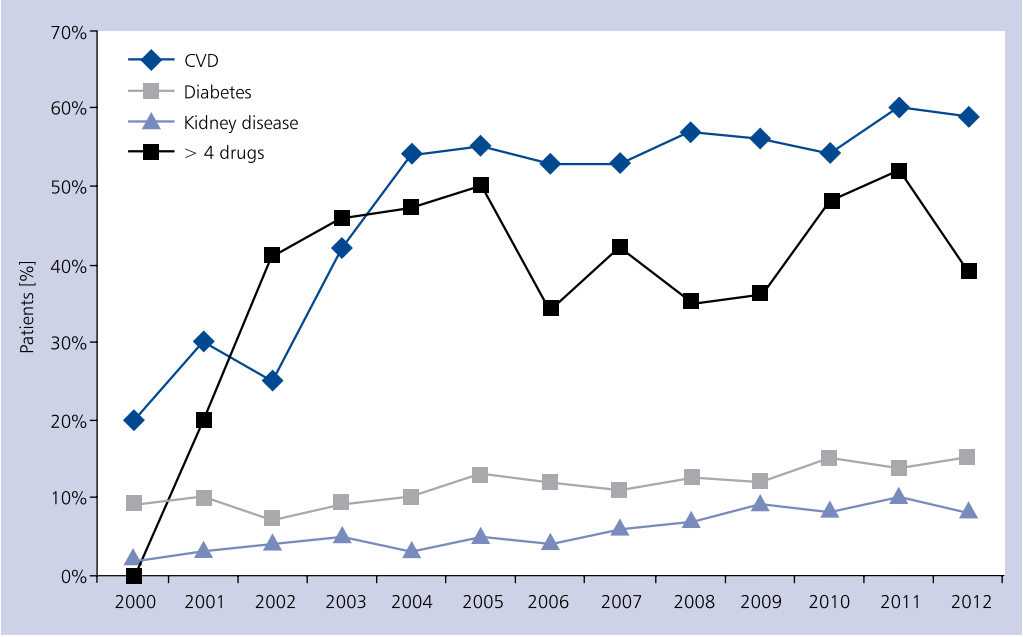

Figure 1. Prevalence of comorbidities in patients scheduled for orthopaedic surgery (based on data from: Baker PN, Salar O, Ollivere BJ, et al. BMJ Open 2014; 4: e004405. doi: 10.1136/bmjopen-2013-004405); CVD — cardiovascular disease

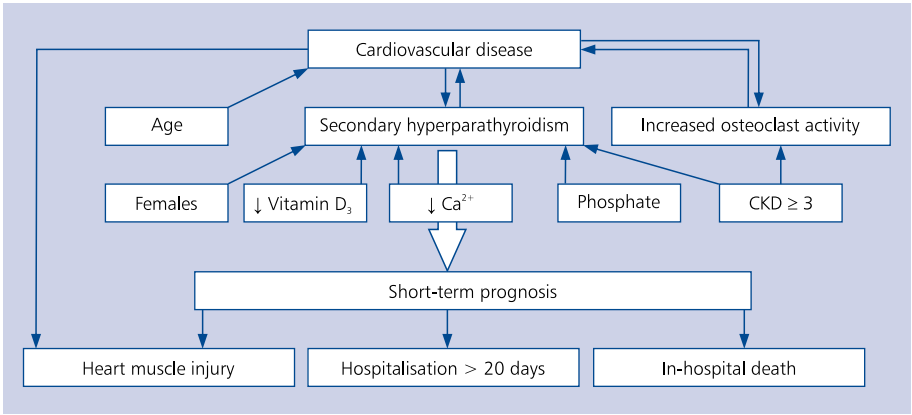

Figure 2. Relationship between cardiovascular and orthopaedic disease (modified after: Fisher A, Srikusalanukul W, Davis M, et al. Clin Interv Aging. 2013; 8: 239–256. doi: 10.2147/CIA.S38856); CKD — chronic kidney disease

the patient, changes in body temperature, and type of anaesthesia contribute to the haemodynamic stress for the patient. Pathogenesis of cardiovascular and orthopaedic association are shown in Figure 2.

It may explain why CVD remains one of the main causes of death in the perioperative period (Fig. 3).

Effective strategies for reducing the risk of cardiac complications in the perioperative period should include assessment of cardiac risk factors, carried out by interviews before surgery. The extent of preoperative cardiac evaluation must be tailored to the patient's clinical condition, age, and the urgency of the operation [15]. Preoperative cardiac assessment, as recommended by the American and European Heart Associations [17, 18], enables improved cardiac treatment and reduction of cardiac complications. However, despite the high incidence of cardiac disease [19] and dehydration in these patients [20], there is often a reluctance to perform preoperative cardiac investigations such as echocardiography or to utilise intensive perioperative monitoring, due to the urgency of surgery and advanced patient age [21].

Currently, we have several clinical tools that ease the cardiac assessment of patients. They include the

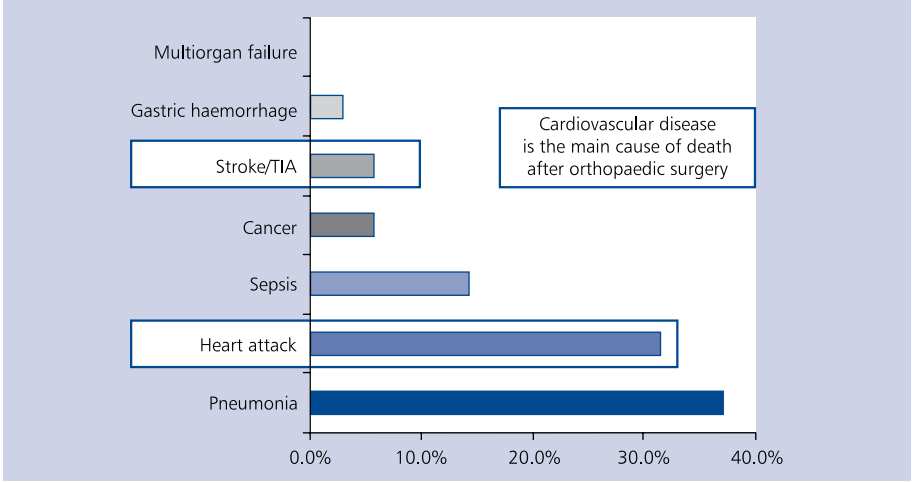

Figure 3. Cause of death during non-cardiac surgery (modified after: Khan MA, Hossain FS, Ahmed I, et al. Int Orthop. 2013; 37: 2119–2124, doi: 10.1007/s00264-013-2068-1); TIA — transient ischaemic attack

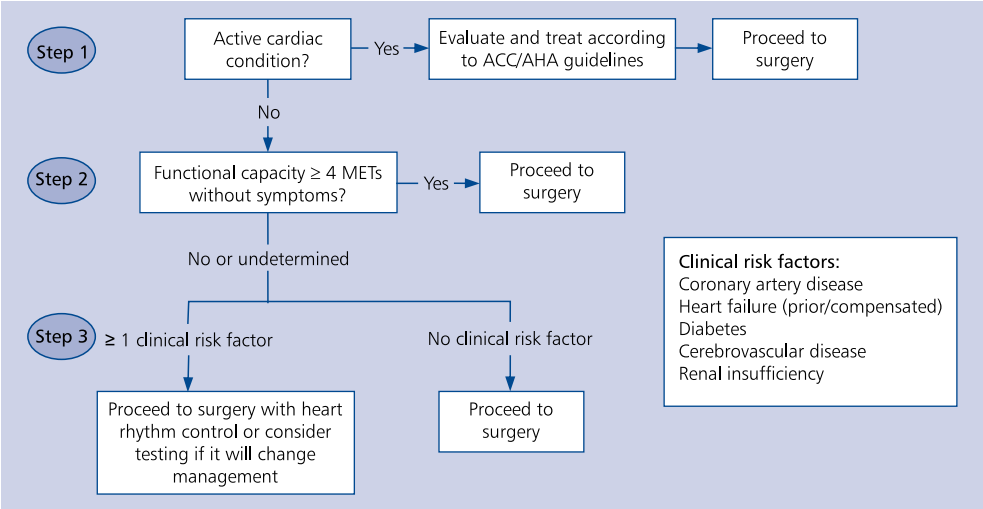

Figure 4. Cardiac evaluation and care algorithm for semi-urgent hip repair (after: Siu CW, Sun NC, Lau TW, et al. Osteoporos Int. 2010; 21: S587–S591, doi: 10.1007/s00198-010-1393-0)

Revised Cardiac Risk Index (RCRI) or MICA calculator derived from the National Surgical Quality Improvement Plan [NSQIP] [22]. The newer ACS-NSQIP calculator includes 20 patient risk factors in addition to the surgical procedure:

— Surgery-specific risk (RCRI and NSQIP). The reported rate of cardiac death or non-fatal myocardial infarction is more than 5% in high-risk procedures, between 1% and 5% in intermediate-risk procedures, and less than 1% in low-risk procedures. Institutional and/or individual surgeon experience with the procedure may increase or lower the risk. Emergency surgery is associated with a particularly high risk; cardiac complications are two to five times more likely than with elective procedures;
— History of ischaemic heart disease (RCRI);
— History of heart failure (RCRI);
— History of cerebrovascular disease (RCRI);
— Insulin dependent diabetes mellitus (RCRI);
— Preoperative serum creatinine ≥ 2.0 mg/dL (RCRI) or > 1.5 mg/dL (NSQIP);
— Increasing age (NQSIP);
— American Society of Anaesthesiologist class (NSQIP);
— Preoperative functional status (NSQIP).

Another tool is based on the scheme presented in Figure 4.

ADVANTAGES GAINED BY MODIFYING CARDIOVASCULAR RISK IN ORTHOPAEDIC PATIENTS

All the above-mentioned algorithms should be introduced into clinical practice because of the potential advantages of treatment of CVD. First of all, it was shown that cardiovascular risk factors themselves contribute to the development of hip fractures. In a cohort of 31,936 Swedish patients it was shown that the hazard ratio (HR) of hip fracture after a diagnosis of heart failure was 4.40 (95% confidence interval [CI] 3.43–5.63); after a stroke, the HR was 5.09 (95% CI 4.18–6.20); after a diagnosis of peripheral atherosclerosis, the HR was 3.20 (95% CI 2.28–4.50); and after an ischaemic heart disease event, the HR was 2.32 (95% CI 1.91–2.84) [23].

It was also proven that treatment and modification of those risk factors improves patients' prognosis. For example, in a recent study concerning 39,938 patients with and without hypertensive treatment, who experienced a primary hip fracture [24], the risk of hip fracture was decreased among people exposed to the majority of hypotensive drugs, including thiazides, beta-blockers, calcium channel blockers, and angiotensin II receptor blockers. The protective associations were stronger among exposed men than among exposed women for all drugs except loop diuretics. These results can be associated also with accelerated healing and lower risk of reoperation.

Other risk factors, including thromboembolism, were also reduced following treatment of cardiovascular risk factors. In a study under the acronym PEP [25], it was shown in a multi-centre group of 13,356 patients undergoing surgery for hip fracture that treatment with 160 mg of daily aspirin started preoperatively and continued for 35 days was associated with reductions in pulmonary embolism of 43% (95% CI 18–60; $p = 0.002$) and in symptomatic deep-vein thrombosis of 29% (95% CI 3–48; $p = 0.03$). Hence, there is now good evidence for considering aspirin routinely in a wide range of surgical and medical groups at high risk of venous thromboembolism.

In a study summing up enhanced clinical pathway (CP) of pre-surgery screening, it was shown that implementation of such assessment resulted in nine (1%) patients in the CP group experiencing postoperative congestive heart failure, compared with 37 (5%) control patients ($p < 0.001$). Postoperative cardiac arrhythmias were significantly lower in the CP group than in the control group (8 [1%] vs. 36 [5%]; $p < 0.001$). Postoperative delirium occurred in 22% of the CP group and 51% of the control group ($p < 0.001$). Therefore, the effect of changing trends in medical care resulted in improved prognosis of patients.

CONCLUSIONS

In summary, orthopaedic surgeries, in particular total hip and knee replacement, represent a growing burden of medical care and are associated with an increasingly aged an morbid population. Early surgery may reduce in-hospital, short-term, and long-term morbidity and mortality, but it can only be performed along with prompt cardiac assessment and minimisation of unnecessary delays for cardiac clearance. Close collaboration between cardiologists and orthopaedic surgeons is needed in order to facilitate ideal patient management.

Conflict of interest: *none declared*

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Cite this article as: Łęgosz P, Platek AE, Board TN, Szymański FM. Cardioorthopedics — is it necessary in clinical practice? A study of patients with hip replacement surgery. Kardiol Pol. 2017; 75(8): 729–735, doi: 10.5603/KP.2017.0151.