ONLINE FIRST

This is a provisional PDF only. Copyedited and fully formatted version will be made available soon.

CARDIOLOGY JOURNAL

ISSN: 1897-5593

e-ISSN: 1898-018X

Impact of musculoskeletal disorders in patients using orthopedic equipment on sternotomy wound healing after cardiac surgery - preliminary report.

Authors: Krzysztof Greberski, Maciej Łuczak, Cezary Danielecki, Karol Buszkiewicz, Olga Kazimierczak, Paweł Burchardt, Bartłomiej Perek, Przemysław Lisiński, Paweł Bugajski

DOI: 10.5603/cj.95753

Article type: Original Article

Submitted: 2023-05-26

Accepted: 2024-04-10

Published online: 2024-07-17

Original article

Impact of musculoskeletal disorders in patients using orthopedic equipment on sternotomy wound healing after cardiac surgery — preliminary report

Running title: Patients with orthopedic malady after sternotomy-wound healing issue

Krzysztof Greberski[1, 2 https://orcid.org/0000-0003-1002-4738], Maciej Łuczak[2], Cezary Danielecki[2], Karol Buszkiewicz[2], Olga Kaźmierczak[3], Paweł Burchardt[4, 5], Bartłomiej Perek[6], Przemysław Lisiński[7] and Paweł Bugajski[1, 2]

[1]Department of the Prevention of Cardiovascular Diseases, Poznan University of Medical Sciences, Poznan, Poland

[2]Department of Cardiac Surgery, J Strus Multidisciplinary Hospital, Poznan, Poland

[3]College of Education and Therapy Kazimiera Milanowska, Poznan, Poland

[4]Department of Cardiology, J Strus Multidisciplinary Hospital, Poznan, Poland

[5]Department of Hypertension, Angiology and Internal Medicine, Poznan University of Medical Sciences, Poznan, Poland

[6]Department of Cardiac Surgery and Transplantology, Poznan University of Medical Sciences, Poznan, Poland

[7]Department and Clinic for Rehabilitation and Physiotherapy, University of Medical Sciences, Poznan, Poland

DOI: 10.5603/cj.95753

Submitted: 26.05.2023

Accepted: 10.04.2024

Address for correspondence:

Krzysztof Greberski, MD PhD, Department of Cardiac Surgery, J Strus Multidisciplinary Hospital, Szwajcarska 3 St., 61–285 Poznań, Poland; tel: +48 728 470 460; e-mail: kgreberski@gmail.com

Abstract

Background: *The presence of locomotive disorders may negatively impact the outcome of cardiac surgeries. This retrospective study aimed to assess the effect of preoperative diagnosis of locomotive disorders requiring the continuous use of orthopedic devices on postoperative rehabilitation and stable sternum adhesion.*

Material and methods: *The study included 122 patients who underwent cardiac surgery, with 68 patients in the study group having a musculoskeletal disorder and 54 patients in the control group without such disorders. Preoperative demographic, clinical, and laboratory data as well as postoperative rehabilitation and sternum adhesion were evaluated.*

Results: *The results showed that patients in the study group had lower levels of calcium ($p < 0.001$), vitamin D ($p < 0.001$), and creatine kinase ($p = 0.022$) prior to the surgery. In the early postoperative period, 8 patients from the study group and 4 from the control group required reoperation due to sternal instability (p = ns). In the late postoperative period, sternal instability was present in 2 patients from the study group and 3 from the control group (p = ns). The survey study revealed a significantly better ($p = 0.029$) evaluation of postoperative rehabilitation among the study group patients.*

Conclusions: *Overall, the results indicated that a preoperative locomotive disorder has no significant impact on sternal instability in the early or late postoperative periods. However, patients with such disorders have a better understanding of the importance, purpose, and course of rehabilitation after cardiac surgery and exhibit lower levels of calcium, vitamin D, and creatinine.*

Keywords: Musculoskeletal disorders; cardiac surgery; sternotomy; complications

Introduction

Currently, in modern cardiac surgery, non-invasive operations without cutting through parts of, or the entire sternum are becoming more popular. However, median sternotomy is still the access of choice in most facilities during cardiac surgery and surgery on large vessels. The priority in such operations is to make sure the sternum heals properly as well as avoiding any infections of the surgical site (surgical site/wound infection; SWI), particularly a deep infection (deep SWI; DSWI), i.e. when the disease affects the sternum and the tissues below. It should be emphasised that even superficial infections (superficial SWI; SSWI) with tissue necrosis followed by their granulation could lead to extensive and unwanted scarring which requires great care and attention and leads to a longer stay in a hospital [1]. When concomitance of sternal instability and DSWI occurs, it is not always possible to determine which came first; whether it was the infection which led to sternal instability, or if the instability aided in the onset of infection. Patients with locomotive pathologies, older patients in particular, have a higher risk of the above-mentioned post-operative complications [2]. In this group, the number of people utilising orthopaedic devices is larger than in younger people. So far, there have been few examples in professional literature devoted to studying the correlation between the existence of preoperative musculoskeletal diseases requiring orthopaedic devices and the healing processes of bones (i.e. getting stable adhesion) and the surgical wound. Moreover, the abovementioned locomotive pathologies may make post-operative rehabilitation more difficult and lengthen the time needed to get back to the previous locomotive functionality.

Taking everything into account this paper aims to assess the impact of preoperative locomotive disorder requiring the use of orthopaedic devices on the healing of the sternum and gaining its stability in further observation among the patients who had undergone medial sternotomy.

Material and methods

Studied population

122 patients were included in this retrospective study, including 30 women and 92 men whose age was on average 72 ± 7 years, who had undergone cardiac surgery with access through full medial sternotomy from January 2018 to December 2020. In 68 of the patients, musculoskeletal pathology requiring a continuous use of orthopaedic devices had been diagnosed before the operation, while the control group consisted of 54 patients with no locomotive limitations. The local bioethics committee of the "Poznan University of Medical Sciences" (Poland), confirmed that the research is not a medical experiment. The study was conducted in accordance with the Declaration of Helsinki, and each patient taking part in the survey study gave their consent prior to the study.

Pre-operative period

The patients were admitted to a hospital one day before the operation in order to complete a medical interview, a physical examination, and laboratory (blood count, creatinine, CK, CK-MB, CRP, TnI, APTT, INR, ALP, HbA1c, as well as fibrinogen levels, 25-OH Vit D, calcium, and phosphorous) and imaging examinations (ECHO, thorax X-ray). Detailed demographic and clinical data as well as examination results are presented in table 1.

Operation

The patients in the study underwent cardiac surgery of various kinds (coronary bypass grafting surgery, valvular disease, etc.) under general anaesthesia. The common element among all patients was surgical access through full medial sternotomy. After the operation, the sternum was closed using single loops of wire encirclages. Table 1 presents a detailed quantitative breakdown of different types of operations in both groups.

Post-operative period and survey studies

The patients were woken up after being transported from the recovery room to the cardiac intensive care room. In the post-operative period, after removing the thoracic drainage, patients were given sternal anastomosis protection in the form of a belt stabilizing the pectoral girdle. Every patient was subject to a control examination of the sternotomy wound on the day of discharge, during the outpatient examination after 4 weeks and in a survey conducted, on average, 24 months after the operation. A lower number of patients (emigration, changing their phone number) took part in a telephone survey consisting of seven questions — a total of 82 patients (study group n = 41, control group n = 41). The patients answered questions regarding the stages of post-operative rehabilitation, body mass gain or loss, sternal stability, general health, and other orthopaedic operations.

Statistical analysis

The compliance of the constant variables retrieved from medical data with normal distribution was evaluated utilising the Shapiro-Wilk test. In order to compare the quantitative variables with normal distribution and equal variance, the Student t-test for uncorrelated trials was utilised. In cases of inconsistency with normal distribution, the Mann-Whitney U test was used. Correlations between qualitative variables were defined using the chi-square independence test or Fisher's exact test. A multivariate, stepwise forward logistic regression analysis was conducted to determine independent predictors of musculoskeletal pathology requiring a continuous use of orthopaedic devices in the analyzed population. The criterion for a variable entry into the logistic model was a univariate probability level of $p < 0.05$. The quality of the fit of the logistic model was tested with the Hosmer and Lemeshow test.

A questionnaire evaluating the future results of cardiac treatment and its influence on quality of life was based on a number of categorical variables measured on a qualitative scale. The resulting values were described using numbers and percentages. A comparative analysis was conducted similarly to retrospective parameters, using Pearson's chi-square or Fisher's exact test if any of the expected values was < 1 or if more than 20% of the expected numbers were < 5.

The results whose p value was lower than 0.05 were deemed statistically relevant. The STATISTICA 13 (StatSoft) software was used to conduct the analysis and present the results graphically.

Results

Pre-operative data

The statistical analysis showed several statistically relevant differences between the patient groups. Before the operation, the patients with a musculoskeletal disorder had a lower systolic blood pressure ($p = 0.005$), while their laboratory results showed lower levels of calcium ($p < 0.001$), vitamin D ($p < 0.001$) and creatinine kinase ($p = 0.022$) in the serum in comparison with the control group. The subjects were older ($p = 0.016$), had more leukocytes ($p = 0.022$), a higher concentration of creatinine kinase MB (CK-MB) ($p = 0.023$), a higher international normalised ratio (INR) ($p = 0.007$) and fibrinogen ($p = 0.003$) in comparison with the control group.

Predictors of musculoskeletal pathology

Variables that were found to be significant were entered into a multivariate model to determine which factors were the strongest predictors of musculoskeletal pathology. On multivariate analysis an increase in fibrinogen levels ($p = 0.004$; OR 1.010; 95% CI 1.003–1,017) (p: p-value; OR: odds ratio; CI: confidence interval) and a decrease in platelets ($p = 0.023$; OR 0.985; 95% CI 0.973–0.998) and total calcium ($p = 0.019$; OR 0.004; 95% CI 0.000–0.415) levels remained significant ($p < 0.000$) as predictors of musculoskeletal disorders.

Survey studies

The telephone survey did not show the influence of a locomotive disorder requiring a continuous use of orthopaedic equipment on sternal stability ($p = 0.500$). Based on the questionnaire, it can be concluded that the patients in the study group had a better evaluation of the rehabilitation post cardiac surgery ($p = 0.029$), received specialist care in the post-operative period more rarely ($p < 0.001$), and underwent orthopaedic operation in the post-operative period more often ($p < 0.001$).

Discussion

As the body ages, physical efficiency lowers, disabilities occur most often, and the number of concomitant chronic diseases grows [2]. Osteoporosis is one of the diseases of old age. It leads to lower levels of calcium and vitamin D in the blood. The latest research emphasises the influence of low vitamin D levels on the cardiovascular system through the vascular endothelium and myocyte dysfunction [3–4]. The conducted multivariate analysis highlighted the importance of low total calcium levels on musculoskeletal dysfunctions.

Research showed a correlation between lower bone density and arteriosclerosis both in women and men [5]; the effect is the term “bone vascular paradox” used in relevant publications [6]. The analysis of the relation between osteoporosis and vascular diseases [7] provided insight into why cardiac surgery was more common among patients with a locomotive disability.

Slow wound healing after sternotomy is one of the most serious problems in cardiac surgery. Thus, the topic has been extensively researched in the context of predisposing factors. The meta-analysis by Balachandran et al. [8] showed an influence of the female sex, diabetes type 2, obesity, and harvesting thoracic grafts on the frequency of post-operative sternal infection.

According to relevant literature, the frequency of deep sternal wound infection (DSWI) causing its instability ranges between 0.2% and 3% [9, 10].

It seems obvious that proper rehabilitation for patients with a locomotive disorder helps to avoid problems with post-sternotomy wound healing. The conducted research did not, however, show any correlation between a locomotive disorder requiring a use of orthopaedic devices and a slower sternal healing after cardiac surgery, which is immensely important, as the number of such people is increasing.

The multifactor frailty syndrome, also known in gerontology as frailty syndrome [11], accompanies, and may even cause, locomotive disability [11, 12]. Its etiology is not yet fully known. The state is connected to a higher level of fibrinogen and a large number of inflammatory markers, including C-reactive protein, cytokines, other factors of clotting, and interleukin 6 [14]. The presented results have confirmed some of the above observations. The group of people using orthopaedic equipment due to locomotive disability exhibited pathologies of the clotting system manifested by a higher level of INR (fig. 1) and fibrinogen levels (fig. 2). High fibrinogen levels predispose to musculoskeletal disorders, as shown by multivariate analysis.

Coagulopathies following liver disease may correlate with its disfunction caused by drug toxicity. In this context, many authors pointed towards the particularly toxic role of the chronic use of paracetamol [15]. Nonsteroidal anti-inflammatory drugs are widely used in rheumatology and traumatology and are the first-line medications in rheumatoid arthritis. This can be explained by the concomitance of the frailty syndrome with the elements of musculoskeletal disorder requiring pharmacotherapy and the use of orthopedic equipment [2, 12].

The proven complications of the frailty syndrome include a higher number of falls, loss of independency and a higher risk of death. Falls, particularly among patients with clinical and laboratory osteoporosis markers, lower levels of vitamin D and calcium, are the main cause of bone fractures leading to disability. Thus, the patients from the study group (who exhibit lower levels of vitamin D — fig. 3 and calcium — fig. 4) may be more uncertain when moving, particularly in new, previously unknown conditions, due to having prior treatment experience and musculoskeletal prosthetics. Falls of aged people are among the “geriatric giants”, reflecting their consequences. The consequences may be physical, psychological, economic and/or social. Many researchers focused on the role of the environment of the person in danger: steep stairs, lack of railing, improper lighting, tall doorsteps and unregulated furniture height – conditions that contribute to the risk of falling[16].

It is interesting that the studied patients who used devices aiding their musculoskeletal system, despite the lower availability of specialist treatment, rated the subsequent stages of post-operative rehabilitation higher than the control group (fig. 5). It is likely connected with a feeling of security, intensification of care, and aid related to the conducted hospitalization.

Other research showed a higher body mass index (BMI) in patients with a locomotive disability, but in the conducted research, there was no relevant BMI difference. Literature shows that frailty syndrome is often related to malnutrition; however, in the age of the obesity epidemic, it may be connected with a higher BMI [17].

Many reports indicate the concomitance of the frailty syndrome, locomotive disability, chronic inflammation and clotting disorders, as well as coronary heart disease diagnosed on the basis of a heart attack [12, 18, 19]. These observations are confirmed by the fact that the vast majority of patients in the study group (patients with inhibited motor functions) had undergone a coronary artery bypass grafting surgery due to advanced coronary heart disease (67.6%).

It should be suspected that, in most cases, cardiac surgery would allow patients from the study group to undergo orthopaedic treatment at a later date. Better blood circulation and heart valve function removed contraindications against anaesthesia before other surgical operations.

The study was limited by a relatively low number of patients and a lack of relevant publications; thus, further research is required.

Conclusions

Although patients with a pre-operative muscular dysfunction (requiring a continuous use of orthopaedic devices) differ in laboratory parameters from those without this inconvenience, no relevant influence of these differences on sternal stability has been shown in the early pre-operative period and in further observations. These patients rate the rehabilitation after cardiac surgery much higher.

Conflict of interests: The authors declare that they have no conflict of interest.

Funding: None declared.

References

1. Carrel A, Hartmann A. cicatrization of wounds. J Exp Med. 1916; 24(5): 429–450, doi: 10.1084/jem.24.5.429, indexed in Pubmed: 19868052.
2. Mitnitski AB, Graham JE, Mogilner AJ, et al. Frailty, fitness and late-life mortality in relation to chronological and biological age. BMC Geriatr. 2002; 2: 1, doi: 10.1186/1471-2318-2-1, indexed in Pubmed: 11897015.
3. Merke J, Milde P, Lewicka S, et al. Identification and regulation of 1,25-dihydroxyvitamin D3 receptor activity and biosynthesis of 1,25-dihydroxyvitamin D3. Studies in cultured bovine aortic endothelial cells and human dermal capillaries. J Clin

Invest. 1989; 83(6): 1903–1915, doi: 10.1172/JCI114097, indexed in Pubmed: 2542376.

4. Li YC, Kong J, Wei M, et al. 1,25-Dihydroxyvitamin D(3) is a negative endocrine regulator of the renin-angiotensin system. J Clin Invest. 2002; 110(2): 229–238, doi: 10.1172/JCI15219, indexed in Pubmed: 12122115.
5. Ye C, Xu M, Wang S, et al. Decreased bone mineral density is an independent predictor for the development of atherosclerosis: A systematic review and meta-analysis. PLoS One. 2016; 11(5): e0154740, doi: 10.1371/journal.pone.0154740, indexed in Pubmed: 27149062.
6. Kawecka E, Rozentryt P, Niedziela J, et al. Niewydolność serca Osteoporoza i osteopenia u chorych z niewydolnością serca. Kardiologia Oparta na Faktach. 2010; 2: 161–6.
7. Zapolski T, Kornecki W, Wysokiński A. Osteoporoza a choroby układu sercowo-naczyniowego. Choroby Serca i Naczyń. 2017; 14(5): 263–73.
8. Balachandran S, Lee A, Denehy L, et al. Risk factors for sternal complications after cardiac operations: A systematic review. Ann Thorac Surg. 2016; 102(6): 2109–2117, doi: 10.1016/j.athoracsur.2016.05.047, indexed in Pubmed: 27553500.
9. Phoon PH, Hwang NC. Deep sternal wound infection: diagnosis, Treatment and prevention. J Cardiothorac Vasc Anesth. 2020; 34(6): 1602–1613, doi: 10.1053/j.jvca.2019.09.019, indexed in Pubmed: 31623967.
10. Juhl AA, Hody S, Videbaek TS, et al. Deep sternal wound infection after open-heart surgery: A 13-year single institution analysis. Ann Thorac Cardiovasc Surg. 2017; 23(2): 76–82, doi: 10.5761/atcs.oa.16-00196, indexed in Pubmed: 28163297.
11. Życzkowska J, Grądalski T. Zespół słabości (frailty) : co powinien o nim wiedzieć onkolog? Onkologia w Praktyce Klinicznej. 2010; 6(2): 79–84.
12. Gabryś T, Bajorek A, Malinowska-Lipień I. Zespół słabości – zasadniczy problem zdrowotny osób starszych. Część I. Gerontologia Polska. 2015; 1: 29–33.
13. Young J. Red flags in geriatrics: diagnoses not to be missed in acute units. Clinical Medicine. 2007; 7(5): 512–514, doi: 10.7861/clinmedicine.7-5-512, indexed in Pubmed: 17990724.

14. Chen X, Mao G, Leng SX. Frailty syndrome: an overview. Clin Interv Aging. 2014; 9: 433–441, doi: 10.2147/CIA.S45300, indexed in Pubmed: 24672230.

15. Kerr R, Newsome P, Germain L, et al. Effects of acute liver injury on blood coagulation. J Thromb Haemost. 2003; 1(4): 754–759, doi: 10.1046/j.1538-7836.2003.00194.x, indexed in Pubmed: 12871412.

16. Deschka H, Erler S, El-Ayoubi L, et al. Suction-irrigation drainage: an underestimated therapeutic option for surgical treatment of deep sternal wound infections. Interact Cardiovasc Thorac Surg. 2013; 17(1): 85–89, doi: 10.1093/icvts/ivt078, indexed in Pubmed: 23529753.

17. Strandberg TE, Pitkälä KH. Frailty in elderly people. Lancet. 2007; 369(9570): 1328–1329, doi: 10.1016/S0140-6736(07)60613-8, indexed in Pubmed: 17448804.

18. Ferrucci L, Cavazzini C, Corsi A, et al. Biomarkers of frailty in older persons. J Endocrinol Invest. 2002; 25(10 Suppl): 10–15, indexed in Pubmed: 12508906.

19. Sokołowski R, Ciesielska N, Czajkowska A, et al. Patogeneza zespołu kruchości. Journal of Health Sciences. 2014; 4(9): 197–204.

Table 1. Characteristics of patients in Group I (study) and Group II (control)

Coefficient	Group I (study) N = 68	Group II (control) N = 54	p-value
Gender (F/M)	18/50	12/42	0.588[3]
Age (years) (min/max/ $\acute{x}$)	53/81/72.2	45/79/67.6	**0,016**[2]
Height (cm) (min/max/ $\acute{x}$)	150.00/188.00/169.63	148.00/185.00/170.07	0.763[1]
Weight (kg) (min/max/ $\acute{x}$)	50.00/112.00/84.47	53.00/140.00/81.52	0.172[2]
BMI (kg/m^2) (min/max/ $\acute{x}$)	19.05/46.67/29.44	19.75/41.35/28.12	0.140[1]
Diabetes	36	24	0.351[3]
Hypertension	58	39	0.076[3]
Nicotinism	16	16	0.447[3]
Asthma/COPD	7	3	0.384[4]
Previous MI	34	30	0.542[3]
PCI in the past	16	21	0.066[3]
CABG	46	42	0.215[3]
AVR	12	7	0.479[3]
MVR	1	1	1.000[4]
Other cardiovascular surgeries	9	4	0.300[3]
Reoperation due to sternal instability	8	4	0.422[3]
SP (mmHg) (min/max/ $\acute{x}$)	95.00/155.00/116.48	112.00/130.00/118.35	**0.005**[2]
DP (mmHg) (min/max/ $\acute{x}$)	58.00/90.00/79.13	68.00/91.00/79.85	0.691[2]
HR (bpm) (min/max/ $\acute{x}$)	67.00/97.00/78.32	61.00/91.00/77.93	0.817[2]
WBC (x10^3/µL) (min/max/ $\acute{x}$)	4.00/14.10/8.40	4.60/14.80/7.71	**0.022**[2]
Hgb (g/dl) (min/max/ $\acute{x}$)	9.00/15.80/13.27	4.89/16.40/13.15	0.775[2]
RBC (x10^6/µL) (min/max/ $\acute{x}$)	3.08/5.29/4.48	3.67/14.30/4.64	0.624[2]
PLT (x10^3/µL) (min/max/ $\acute{x}$)	103.00/481.00/226.24	131.00/492.00/245.21	0.101[2]
Creatinine (µmol/L) (min/max/ $\acute{x}$)	37.00/194.00/96.77	51.00/257.00/92.48	0.200[2]
CK (IU/L) (min/max/ $\acute{x}$)	26.00/681.00/110.13	32.00/396.00/124.57	**0.034**[2]
CK-MB (IU/L) (min/max/ $\acute{x}$)	11.00/49.00/19.67	9.00/88.00/17.42	**0.023**[2]
CRP (mg/L) (min/max/ $\acute{x}$)	0.00/176.00/12.27	0.00/39.90/5.89	0.085[2]
TnI (ng/L) (min/max/ $\acute{x}$)	0.00/6243.00/199.68	0.00/945.00/67.06	0.698[2]
APTT (s) (min/max/ $\acute{x}$)	0.94/59.00/29.60	23.90/53.50/30.71	0.199[2]
INR (min/max/ $\acute{x}$)	0.97/1.80/1.11	0.91/1.38/1.07	**0.007**[2]
Fibrinogen (mg/dl) (min/max/ $\acute{x}$)	205.00/709.00/412.36	213.00/700.00/354.13	**0.003**[2]
HbA1c (%) (min/max/ $\acute{x}$)	5.00/8.60/6.25	5.00/9.90/6.21	0.626[2]
25-OH Vit D (IU/L) (min/max/ $\acute{x}$)	4.10/47.00/15.83	9.90/45.30/21.38	**0.001**[2]
Total Ca (mmol/L) (min/max/ $\acute{x}$)	1.97/2.53/2.29	2.07/2.72/2.39	**0.001**[1]
ALP (IU/L) (min/max/ $\acute{x}$)	46.00/162.00/78.62	42.00/169.00/80.18	0.627[2]
Phosphorus (mmol/L) (min/max/ $\acute{x}$)	0.71/1.75/1.15	0.81/1.54/1.19	0.161[2]

[1]Student's t-test; [2]Mann–Whitney U test; [3]Pearson's chi-squared test; [4]Fisher's exact test

F— female; M — male; BMI — body mass index; COPD — chronic obstructive pulmonary disease; MI — myocardial infarction; PCI — percutaneous coronary interventions; CABG — coronary artery bypass grafting; AVR — aortic valve replacement; MVR — mitral valve replacement; SP — systolic pressure; DP — diastolic pressure; HR — heart rate; bmp — beats per minute; WBC — white blood cells; Hgb — hemoglobin; RBC — red blood cells; PLT — platelets; CK — creatine kinase; CK-MB — creatine kinase MB; CRP — C-reactive protein; TnI — troponin I; APTT — activated partial thromboplastin time; INR — international normalized ratio; HbA1c — hemoglobin A1c; Vit — vitamin; Ca — calcium; ALP — alkaline phosphatase; min — minimum; max — maximum; $\acute{x}$ — arithmetic mean

Table 2. Characteristics of the orthopedic equipment used in the study group

Orthopedic equipment	Number of patients N = 68	% of the group
Cane	16	23.5
One crutch	25	36.8
Two crutches	20	29.4
Walker	1	1.5
Other	6	8.8

Table 3. Results of survey research

Coefficient	Group I (study) N = 41	Group II (control) N = 41	p-value
Body weight after cardiac surgery (loss ≥ 5 kg/no change/gain ≥ 5 kg)	7/14/20	6/17/18	0.791[1]
Sternum in the postoperative period (stable/unstable)	39/2	38/3	1.000[2]
Postoperative nicotinism	14	16	0.647[1]
Evaluation of postoperative rehabilitation (positive/negative)	40/1	33/8	**0.029**[2]
Health assessment in relation to the pre-operative period (deterioration/ no change/improvement)	4/8/29	6/6/29	0.710[1]
Postoperative treatment in a specialist clinic	12	30	**0.000**[1]
Surgery of locomotor system after cardiac surgery	22	0	**0.000**[1]

[1]Pearson's chi-squared test; [2]Fisher's exact test

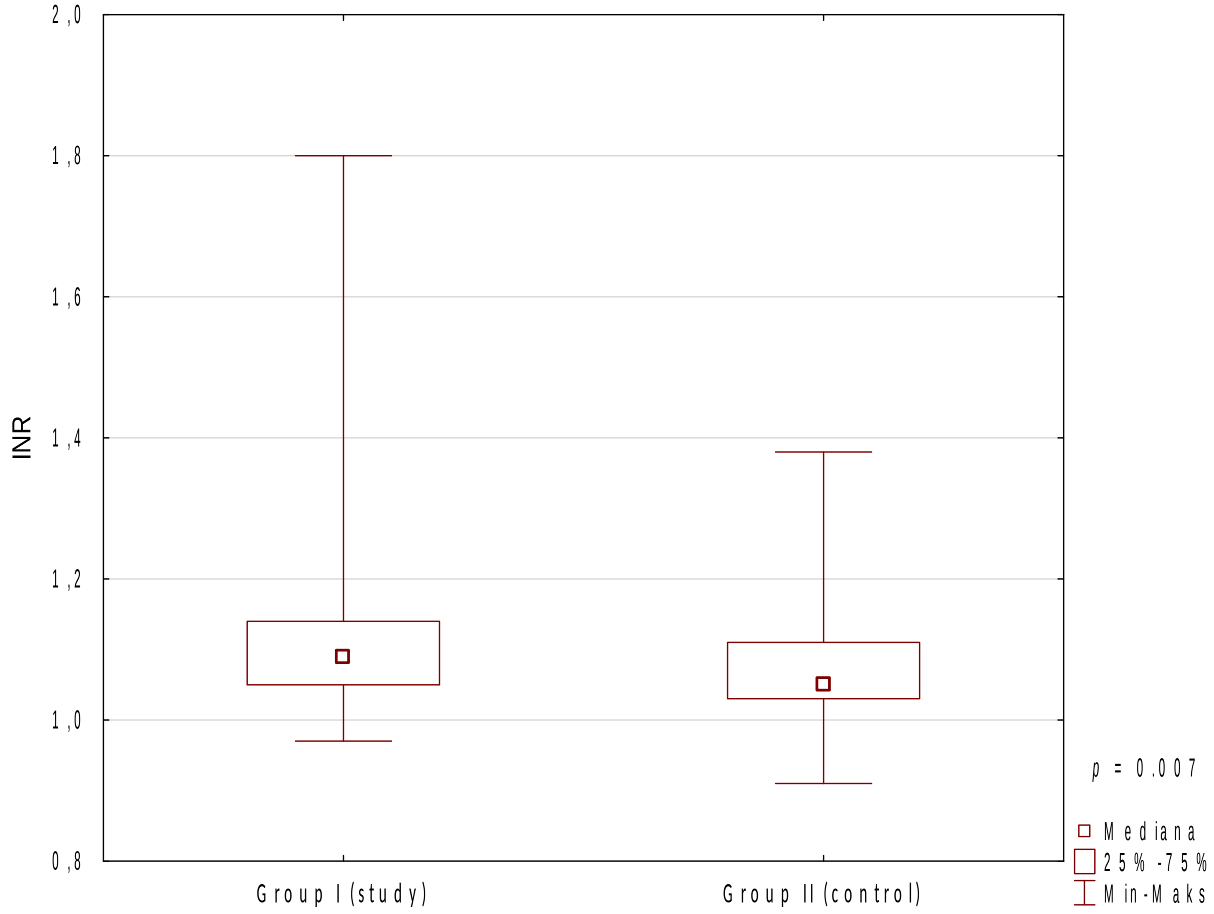

Figure 1. INR values in the study and control groups

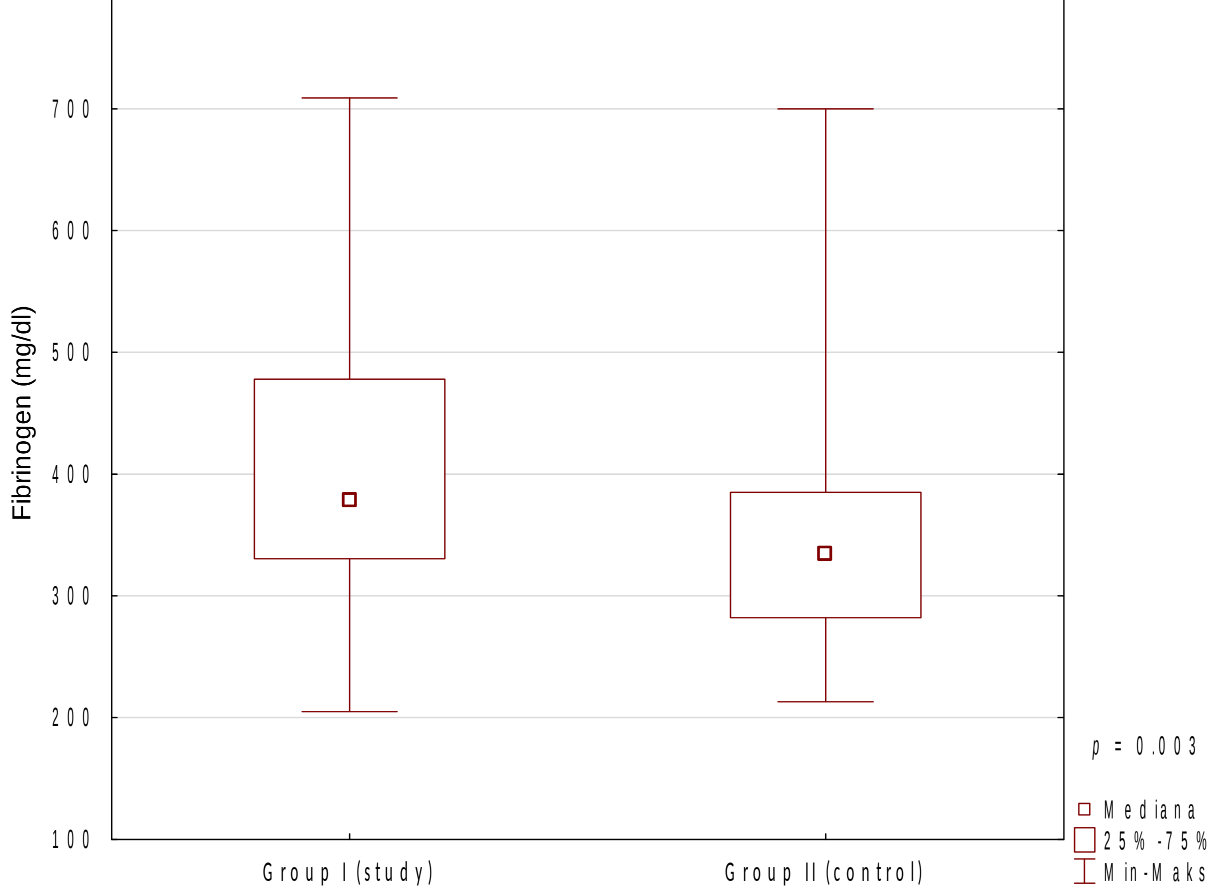

Figure 2. Fibrinogen levels in the study and control groups

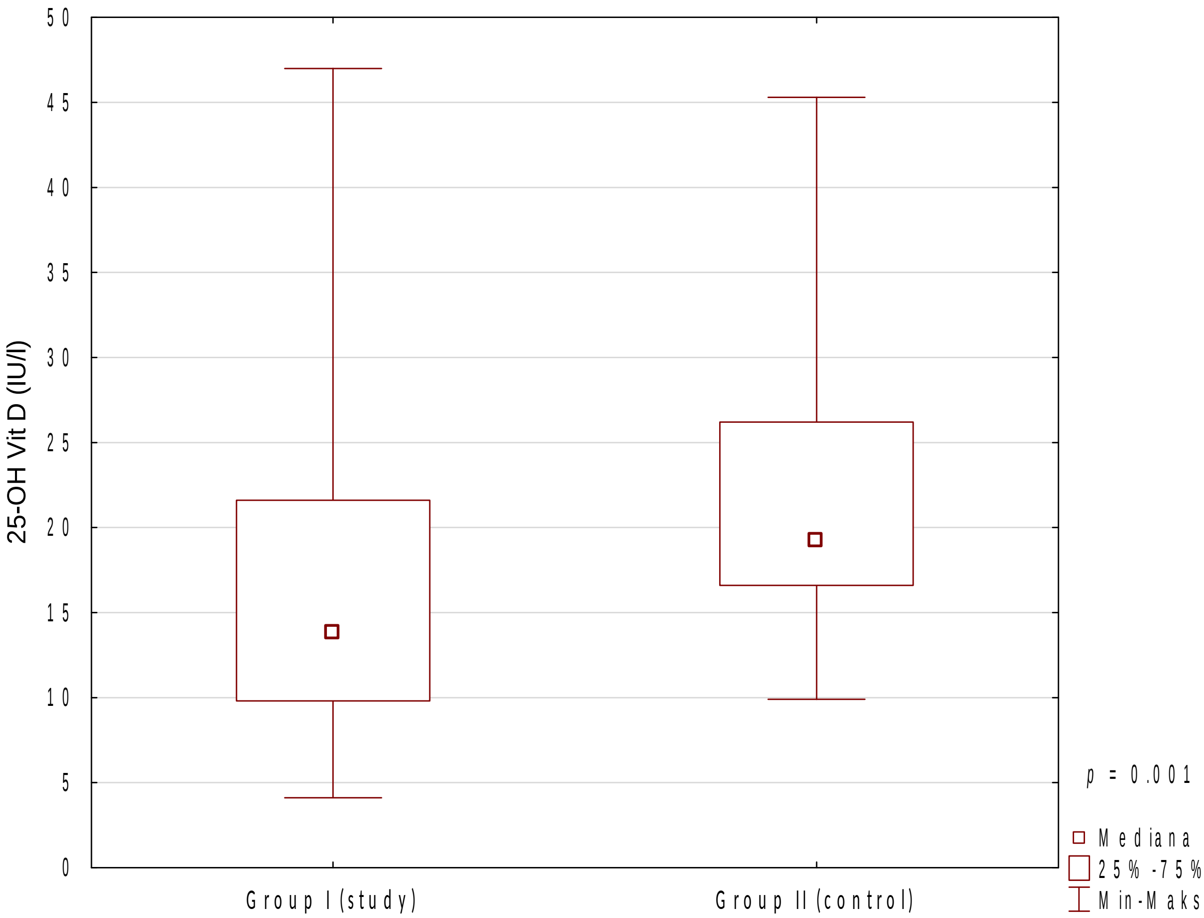

Figure 3. Vitamin D levels in the study and control groups

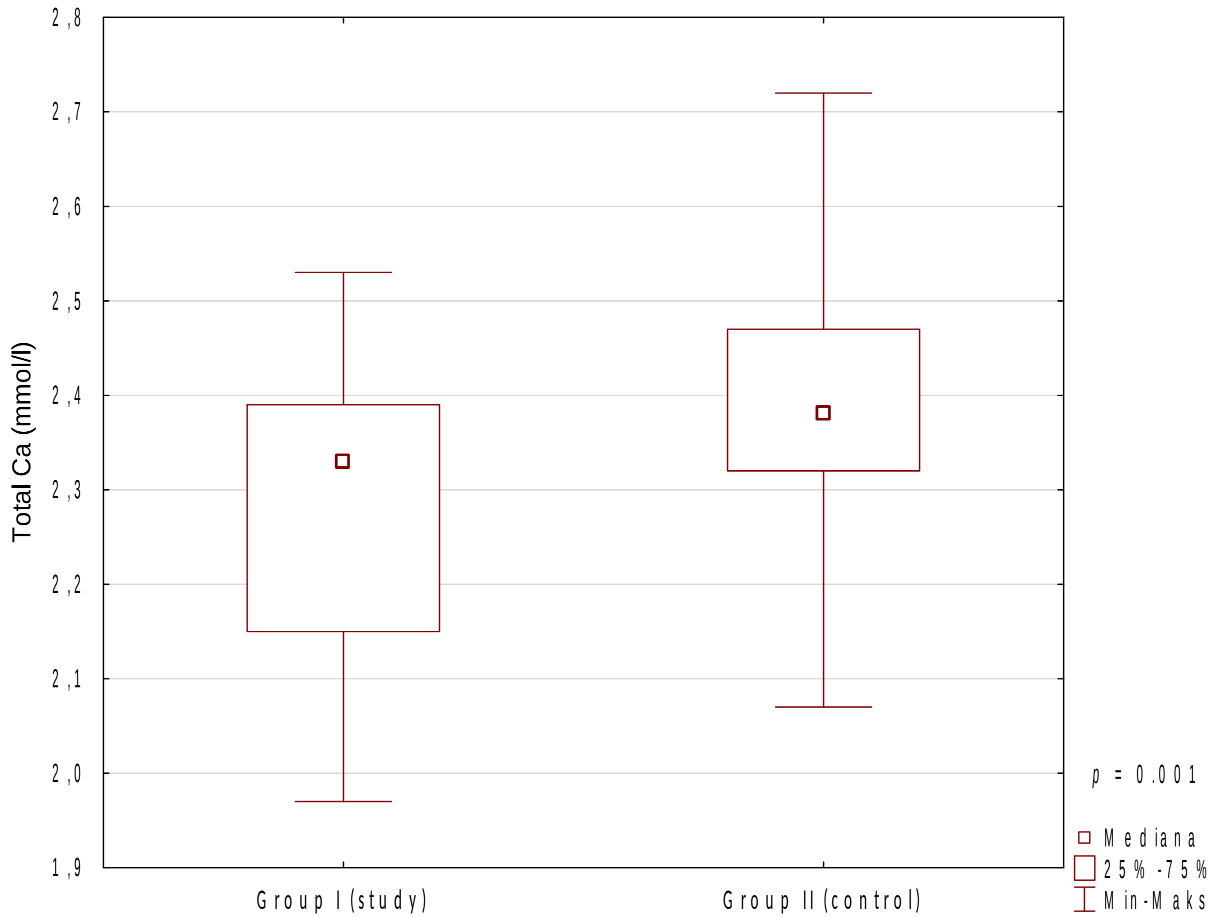

Figure 4. Total calcium levels in the study and control groups

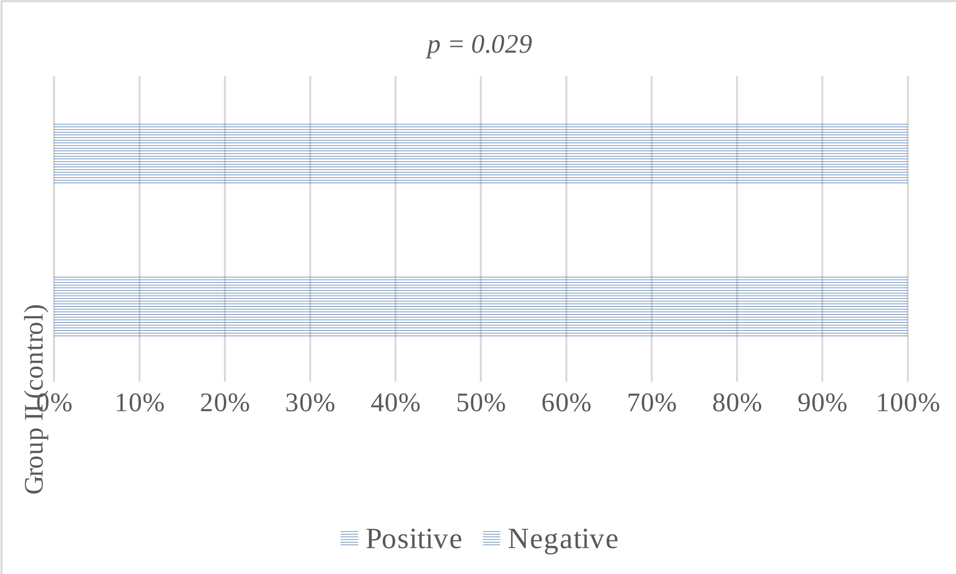

Figure 5. Evaluation of postoperative rehabilitation