Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

GKDA Derg 2023;29(1):1-6
DOI: 10.14744/GKDAD.2023.29052

Research Article

Incidence of Chronic Neuropathic Pain After Open-heart Surgery: A Retrospective Cohort Analysis

Senem Girgin, Birzat Emre Gölboyu

Department of Anesthesiology and Reanimation, Katip Çelebi University Faculty of Medicine, Izmir, Türkiye

ABSTRACT

Objectives: Chronic sternal pain has been reported in 11%–56% of patients 1 year after cardiac surgery with median sternotomy. However, chronic pain after sternotomy can frequently be ignored.

Methods: Patients who received open-heart surgery between January 2020 and June 2022 were included. Data analysis was performed through file scans, hospital data processing system and patient follow-up documents, phone calls, and algology outpatient clinic records. T For the assessment of neuropathic pain, the Turkish version of the pain scale, for which validity and reliability studies were conducted, was employed.

Results: When all patients were analyzed, the incidence of chronic pain was 28.7%, and the incidence of chronic neuropathic pain was 14.7%. There was no difference in age, gender, education level, time after surgery, and smoking. Although the BMI was higher in the group with neuropathic pain when compared, there was no statistically significant difference. The presence of Diabetes Mellitus (DM) diagnosis was statistically significant in the group that created the neuropathic pain group, and no discernible difference was found in terms of other additional diseases. The rate of patients with preoperative angina was discovered to be higher in the neuropathic pain group (p: 0.030). When the type of surgery, urgency, and need for revision were compared, no significant difference was observed between the two groups. When both groups were compared in terms of l the duration of hospital stay was discovered to be longer in the neuropathic pain group (17 [15–19] days, p:0.046).

Conclusion: The incidence of chronic neuropathic pain was estimated to be 14.7%, and it was shown that the presence of DM, preoperative angina, and the long hospital stay might be factors contributing to the development of chronic neuropathic pain.

Keywords: Cardiac surgery, chronic pain, neuropathic pain, sternotomy

Please cite this article as: "Girgin S, Gölboyu BE. Incidence of Chronic Neuropathic Pain After Open-heart Surgery: A Retrospective Cohort Analysis. GKDA Derg 2023;29(1):1-6".

Introduction

Chronic poststernotomy pain is characterized as nonanginal postoperative pain lasting longer than 3 months following median sternotomy. Allodynia, discomfort, hypoesthesia, and chronic pain are some of the possible symptoms.[1]

It has been reported that 11%–56% of patients have chronic sternal pain 1 year after cardiac surgery with median sternotomy.[2,3] Based on the Society of Thoracic Surgery database in the United States, more than 280,000 patients underwent cardiac surgery annually, and 156,800 patients have sternotomy-related chronic pain in the first year after surgery.

However, prolonged sternotomy pain is often ignorable. Chronic sternotomy pain can negatively influence the quality of life by interfering with sleep, mood, activity level, and overall satisfaction if not carefully identified, and treated.[4] There are several causes of pain following thoracotomies or sternotomies, including entrapment neuropathy, muscular damage, sternal pseudoarthrosis, and sternal wires. In addition to postoperative infection, damage to the intercostal nerves during dissection of the internal mammary artery has been identified as a potential contributing factor.[5]

The purpose of this research is to investigate the prevalence of chronic neuropathic pain and potential predispos-

Address for correspondence: Senem Girgin, MD. İzmir Katip Çelebi Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, İzmir, Türkiye

Phone: +90 505 836 97 12 **E-mail:** senemcan@gmail.com

Submitted: January 07, 2023 **Accepted:** February 06, 2023 **Available Online:** March 29, 2023

The Cardiovascular Thoracic Anaesthesia and Intensive Care - Available online at www.gkdaybd.org

ing factors among patients who have received open-heart surgery in our hospital during the last three years.

Methods

The research was planned as a retrospective cohort study following the Helsinki Declaration. After approval by the Ethics Committee of our hospital (November 24, 2022, decision number 0528), patients who had undergone open-heart surgery at Katip Çelebi University Atatürk Education and Research Hospital between January 1, 2020, and July 1, 2022, were included in the study.

Data analysis was conducted using the hospital's data system, including patients' follow-up records, telephone calls, and file records from the algology outpatient clinic. Data from patients whose pain scores were not followed up or reported, who did not want to participate in the research, or who died were considered incomplete data, and data from these individuals were removed from the analysis.

Pain assessment: The Turkish version of the S-LANSS (Self-Leeds Assessment of Neuropathic Symptoms and Signs) pain scale was used to evaluate neuropathic pain. The S-LANSS pain scale consists of 7 items. There is a dual rating type (yes, no). Patients can score between 0 and 24 on the test. While the test supports neuropathic pain in patients with scores of 12 and higher, it supports nociceptive pain in patients with scores below 12.

Grouping and data collection: patient demographics, comorbidities, BMI, type of surgery, history of prior Covid- 19 infection, presence of preoperative neuropathic pain diagnosis, history of covid vaccine, length of hospital stay, hospital and ICU stay were acquired from patient records. Patients were interviewed by telephone or in the algology outpatient clinic utilizing the S-LANSS scale. Those with an S-LANSS score >of 12 points were defined as the neuropathic pain group. Comparing the prevalence and risk variables with the patient population of those without neuropathic pain.

Patients younger than 18 years, who passed away after surgery, who were unable to be reached by telephone, who had been previously diagnosed with neuropathic pain, or who were taking a drug from the group of drugs used to treat neuropathic pain were removed from the study.

Statistical analyzes were conducted using IBM SPSS Statistics for Windows (version 22.0; IBM Corp., Armonk, NY, USA). Descriptive statistics were represented by mean and standard deviation or median-(IQR) for continuous variables and numbers and percentages for categorical variables. Before all analyses, skewness and kurtosis values, the Shapiro-Wilk test, and histogram plots were employed to check whether the data conformed to the normal distribution. T-test for independent variables or dependent variables T-test for variables with normal distribution to examine the differences in means between groups; the Mann–Whitney U test was employed for the variables that did not conform to the normal distribution. The chi-square test or Fischer exact test was utilized to evaluate differences in categorical variables between groups. $p<.05$ was regarded as statistically significant in all analyses.

Results

Data from a total of 129 patients were added to the study. When all patients were analyzed, the incidence of chronic pain was 28.7% and the incidence of chronic neuropathic pain was 14.7%. Table 1 provides details on the demographics, comorbidities, prior surgeries, and hospitalizations of all patients.

Compared with the patient group with neuropathic pain, no difference was observed in the patient group without neuropathic pain in terms of age, sex, education level, time following surgery, and smoking. BMI was higher in the group with neuropathic pain when it was compared, but no statistically significant difference was discovered. When the patients with neuropathic pain were analyzed for their comorbidities, it was observed that the presence of DM was statistically significant compared to the group without neuropathic pain ($p=0.048$); no significant difference was identified for the other comorbidities. The prevalence of patients with preoperative angina was greater in the group with neuropathic pain ($p=0.030$). When comparing the type of surgery, urgency, and need for revision, no discernible difference was observed between the two groups. When comparing the two groups in terms of length of stay in the ICU and hospital, it was discovered that the length of hospital stay was longer in the neuropathic pain group (17 [15–19] days, $p=0.046$) (Table 2).

Discussion

In the current study, evaluating data from 129 patients, we observed that the incidence of chronic pain was 28.7% and the incidence of chronic neuropathic pain was 14.7%. A diagnosis of DM, preoperative angina, and a longer hospital stay were all associated with a higher rate of development of chronic neuropathic pain in those patients.

Pain after chronic sternotomy may result in a variable clinical condition influencing one or more sites. Chronic pain related to cardiac surgery most frequently occurs in the anterior chest wall in patients, although chronic pain may also occur in the upper and lower extremities, neck, and back. This describes the potential challenges in accurately diagnosing chronic pain after median sternotomy. The literature reports a wide range of median incidences of

Table 1. Demographic, comorbidity and surgical data of all patients

Demographic data	n=129	%
Age (years)	60±10	
Gender		
Female	29	22.5
Male	100	77.5
Educational status		
Illiterate	11	8.5
Primary education	80	62
High school	23	17.8
University	15	11.6
Post-surgery time		
3–6 months	1	0.8
6 months–1 year	39	30.2
>1 year	89	69
Body mass index	27±3	
Smoking	28	21.7
Preoperative angina	39	30.2
Emergency surgery	11	8.5
Type of surgery		
CABG	80	62
Valve replacment	15	11.6
CABG+Valve	34	26.4
Saphenous graft	86	66.7
Internal mammarian artery graft (IMA)	54	41.9
Revision surgery (resternotomy)	19	14.7
Chronic pain	37	28.7
Chronic Neuropathic pain	19	14.7
Analgesic usage	11	8.5
Pain location		
Sternum	28	21.7
Saphenous	14	10.9
Intercostal	5	3.9
Comorbidity		
Hypertension (HT)	79	61.2
Diabetes Mellitus (DM)	54	41.9
Coronary Artery Disease	97	75
COPD	22	17
Thyroid dysfunction	12	9.3
Malignancy	5	3.9
Chronic renal failure	5	3.9
Chronic liver disease	5	3.9
Covid-19 infection	43	33.9
ICU stay (days)	3 (3–4)	
Hospital stay (days)	14 (12–17)	

n, %, n ±SD , median (25^{th}-75^{th} percentile). CABG: Coronary artery bypass graft; COPD: Chronic obstructive pulmonary disease; ICU: Intensive care unit.

chronic pain following sternotomy, from 11% to 56% 1 year after surgery. Moreover, the number of patients reporting the development of chronic pain reduces over time. Several factors, including differences in the definition and diagnosis of pain after chronic sternotomy, variations in surgical methods and techniques, additional medical and psychological issues that may impact the ability to manage pain, physical and emotional stress, and individual patient-specific factors may contribute to this increased incidence, which is considered variable in the literature. The prevalence of chronic pain following cardiac surgery may be influenced by heterogeneity in study designs.[6]

The emergence of persistent sternotomy-related discomfort may be influenced by age. A higher incidence of chronic postoperative pain, as well as higher pain intensity, has been observed in patients older than 70 years compared with younger patients.[7] In a recent multicenter retrospective analysis, although no difference was seen in the incidence of chronic pain 3 months and 1 year after surgery, a considerably greater incidence of chronic pain 3 years after surgery was observed in patients older than 75 years.[1] However, in our research, no significant difference was discovered between the mean age of the two groups. Nevertheless, because the period following open-heart surgery was 2 years or less, the findings addressing the incidence of developing discomfort after chronic sternotomy in the long-term are unknown in the research group of patients.

Gender may also contribute to the development of chronic pain. After sternotomy, women are more likely to suffer from chronic sternal discomfort in the first year. According to reports, this difference was not there a year following surgery.[8] In the WREST -E study, which particularly analyzed the incidence of chronic pain after sternotomy in women, an incidence of 47% was reported 1 year after surgery; these findings were greater than in previous studies involving both men and women.[9] In our research, no considerable difference in the development of neuropathic pain was found when comparing the gender. Similar to other risk factors for the development of chronic pain, the evidence for gender as a predictor is not satisfactory, as other studies have not demonstrated a consistent relationship between patient gender and chronic pain. The lower percentage of female patients who received cardiac surgery and were included in these studies may describe the variable impact of gender on pain.[10]

In our study, patients' comorbidities were compared between those with and without chronic neuropathic pain. DM was observed to be more prevalent in the group with chronic neuropathic pain. However, no significant difference was observed between the groups in terms of other comorbidities. According to the research, people with hypothyroidism are more likely to experience chronic discomfort following sternotom. Hypothyroidism is thought to contribute to neuropathic pain, although the precise underlying mechanism is still unclear. It has been proposed that demyelination, ami-

Table 2. Comparison of patients with and without chronic neuropathic pain

Comparison between groups	Neuropathic pain n=19	No-Neuropathic pain n=110	p
Age	56±13	60±10	0.141
Gender			
Female/Male	7/12	22/88	0.135
Educational status			
Illiterate	4	7	0.150
Primary education	10	70	
High school	4	19	
University	1	14	
Post-surgery time			
3–6 months	15	74	0.573
6 months–1 year	4	35	
>1 year	0	one	
Body mass index	28±3	27±2	0.070
Smoking	6	22	0.364
Emergency surgery	2	9	0.257
Preoperative angina	10	29	**0.030***
Pain location			
Sternum	14		
Saphenous	7		
Intercostal	3		
Type of surgery			
CABG	12	68	0.288
Valve replacment	3	12	0.345
CABG+Valve	4	30	0.279
Saphenous graft	12	74	0.794
Internal mammarian artery graft (IMA)	12	42	0.592
Revision Surgery (resternotomy)			
Yes/no	1	18	0.304
Comorbidity			
Hypertension (HT)	12	67	1
Diabetes Mellitus (DM)	12	42	**0.048***
Coronary Artery Disease	14	83	0.869
COPD	2	20	0.526
Thyroid dysfunction	2	10	0.690
malignancy	2	4	1
Chronic renal failure	1	4	1
Chronic liver disease	2	3	0.157
Covid-19 infection	8	35	0.443
ICU stay (days)	4 (3–4)	3 (3–4)	0.496†
Length of stay in hospital (days)	17 (15–19)	14 (12–16)	**0.046†**

n, n ±SD , median (25^{th}-75^{th} percentile). Chi-square Test, Student's t-test. *: Mann–Whitney U test; †: p<0.05 (significant values are in italics and bold). CABG: Coronary artery bypass graft; COPD: Chronic obstructive pulmonary disease; ICU: Intensive care unit.

noglycan buildup, and regional hypoxia causing muscular spasms are the causes of the relationship between hypothyroidism and the emergence of chronic pain.[11,12]

The likelihood of developing chronic pain is higher in patients with preoperative chronic pain, particularly those taking opioids and describing angina before surgery.[7] Although a theoretical link has been proposed, it is unclear whether preexisting pain syndromes due to genetic predispositions or other risk factors confer a greater risk of chronic pain or whether the presence of chronic pain before surgery is causally related to postoperative pain through central sensitization and other mechanisms.[13] In our study, findings for the presence of pre-

operative angina were consistent with those documented in the literature. Patients with a previous diagnosis of chronic pain syndrome were removed from the study.

In the WREST -E study, it was found that the incidence of chronic sternal or chest pain increases in obese patients with large chest circumferences.[9] According to a different study, obesity, which is linked to a larger chest circumference in both men and women, increases the likelihood of chronic pain following sternotomy.[7] In the present study, chronic neuropathic patients were compared in terms of BMI, and no considerable difference was found.

Although the impact of the type of surgical intervention is unclear, the requirement for urgent surgical intervention is one of the strongest predictors of the development of chronic pain.[8] Emergency surgery may be connected with greater local tissue trauma due to the more rapid incision, sternotomy, and cannulation strategies. This may increase the development of chronic pain. Although clinical studies on the occurrence of chronic pain after other emergency methods can be observed in the literature, limited data are available because emergency procedures are typically excluded from studies examining risk factors for chronic pain after sternotomy. Further studies including analysis of emergency cardiac surgery are required to characterize this risk.[8,13] When comparing the two groups, our study observed no significant difference in the type and urgency of the procedure.

Brachial plexus injury following median sternotomy primarily influences C8-T1 nerve roots and is related to pain, dysesthesia, and motor deficit in the hand. In most patients, symptoms resolve within 1 week; however, approximately 1% of patients may develop permanent pain or sensory deficit.[14] No brachial plexopathy was found in our patients included in the study.

The incidence of chronic pain is higher in patients who need resternotomy during hospitalization following surgery.[8] The development of chronic pain is most likely exacerbated by repeated tissue trauma and inflammatory reactions related to resternotomy. Despite these observations, a history of sternotomy did not associate with a higher risk of chronic pain following subsequent surgery. The incidence of chronic pain seems to increase in patients with sternal wound infection.[10,12] Wound complications such as infection, mediastinitis, keloid formation, and wound dehiscence have been related to the development of chronic pain after sternotomy.[12] In this research, no difference was observed between the two groups when the presence of resternotomy was analyzed, but our patients included in the study were not investigated for the development of sternal wound infection, so the findings could not be evaluated.

A retrospective study demonstrated an increase in the development of chronic pain after IMA graft removal. Additional tissue trauma was correlated with an increase in acute pain after surgery due to intercostal nerve injury, damage from retraction, and more extensive use of electrocautery.[15] In our study, no considerable difference was observed between the two groups in the use of IMA graft.

It may result from saphenous nerve injury, surgical intervention, trauma, or postoperative subcutaneous suture compression.[16] Chronic leg pain has been described as primarily neuropathic and frequently manifesting as anterior leg dysesthesia in a large case series in the literature. In this case series, it was noted that female patients reported a greater rate of chronic leg pain and its incidence was 8%. They observed that mild or moderate pain severity did not influence their quality of life.[7] Seven patients in this study were found to have chronic neuropathic pain in the saphenous region following saphenous graft removal.

Patients may consider chronic pain after cardiac surgery as "normal" or "to be expected." Therefore, many patients do not report symptoms to their surgeon or cardiologist, which can result in delayed or incorrect diagnosis and treatment. As we observed in the study, a very small percentage of patients taking analgesics.

The present study has several limitations. In this retrospective cohort of patients who had open-heart surgery between 2020 and 2022, the longest follow-up period after surgery is 2 years and cannot be assessed in terms of long-term results. Because of the retrospective design, some clinical information could only be incompletely obtained from patient records and the hospital information system. The evaluation of minimally invasive treatments was inadequate as a result of only including open-heart surgery patients who received sternotomies. Furthermore, the lack of comparison of surgical procedures such as off-pump coronary bypass is among the shortcomings of our study. Another drawback of our study is that wound infections in the early postoperative period were not assessed in individuals with chronic neuropathic pain.

According to the findings of the present study, the incidence of chronic neuropathic pain was estimated to be 14.7%, and it was shown that the presence of DM, preoperative angina, and the long hospital stay might be factors contributing to the development of chronic neuropathic pain.

Patients should be informed and closely monitored for the development of chronic and neuropathic pain after cardiac surgery. Diagnosis and treatment of chronic discomfort should be interdisciplinary, considering the patient's quality of life and functionality.

Disclosures

Ethics Committee Approval: The study was approved by The Katip Çelebi University Non-interventionalClinical Research Ethics Committee (Date: 24/11/2022, No: 0528).

Informed Consent: Written informed consent was obtained from all patients.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Authorship Contributions: Concept – S.G., B.E.G.; Design – S.G., B.E.G.; Supervision – S.G., B.E.G.; Fundings – S.G., B.E.G.; Materials – S.G., B.E.G.; Data collection &/or processing – S.G., B.E.G.; Analysis and/or interpretation – S.G., B.E.G.; Literature search – S.G., B.E.G.; Writing – S.G., B.E.G.; Critical review – S.G., B.E.G.

References

1. Marcassa C, Faggiano P, Greco C, Ambrosetti M, Temporelli PL; Italian Association of Cardiovascular Prevention, et al. A retrospective multicenter study on long-term prevalence of chronic pain after cardiac surgery. J Cardiovasc Med (Hagerstown) 2015;16:768–74.
2. Lahtinen P, Kokki H, Hynynen M. Pain after cardiac surgery: A prospective cohort study of 1-year incidence and intensity. Anesthesiology 2006;105:794–800.
3. Meyerson J, Thelin S, Gordh T, Karlsten R. The incidence of chronic post-sternotomy pain after cardiac surgery--a prospective study. Acta Anaesthesiol Scand 2001;45:940–4.
4. van Leersum NJ, van Leersum RL, Verwey HF, Klautz RJ. Pain symptoms accompanying chronic poststernotomy pain: A pilot study. Pain Med 2010;11:1628–34.
5. Sharma AD, Parmley CL, Sreeram G, Grocott HP. Peripheral nerve injuries during cardiac surgery: Risk factors, diagnosis, prognosis, and prevention. Anesth Analg 2000;91:1358–69.
6. Kleiman AM, Sanders DT, Nemergut EC, Huffmyer JL. Chronic poststernotomy pain: Incidence, risk factors, treatment, prevention, and the anesthesiologist's role. Reg Anesth Pain Med 2017;42:698–708.
7. Bruce J, Drury N, Poobalan AS, Jeffrey RR, Smith WC, Chambers WA. The prevalence of chronic chest and leg pain following cardiac surgery: A historical cohort study. Pain 2003;104:265–73.
8. van Gulik L, Janssen LI, Ahlers SJ, Bruins P, Driessen AH, van Boven WJ, et al. Risk factors for chronic thoracic pain after cardiac surgery via sternotomy. Eur J Cardiothorac Surg 2011;40:1309–13.
9. King KM, Parry M, Southern D, Faris P, Tsuyuki RT. Women's Recovery from Sternotomy-Extension (WREST-E) study: Examining long-term pain and discomfort following sternotomy and their predictors. Heart 2008;94:493–7.
10. Gjeilo KH, Klepstad P, Wahba A, Lydersen S, Stenseth R. Chronic pain after cardiac surgery: A prospective study. Acta Anaesthesiol Scand 2010;54:70–8.
11. Dernellis J, Panaretou M. Effects of thyroid replacement therapy on arterial blood pressure in patients with hypertension and hypothyroidism. Am Heart J 2002;143:718–24.
12. Costa MA, Trentini CA, Schafranski MD, Pipino O, Gomes RZ, Reis ES. Factors associated with the development of chronic post-sternotomy pain: A case-control study. Braz J Cardiovasc Surg 2015;30:552–6.
13. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: Risk factors and prevention. Lancet 2006;367:1618–25.
14. Hanson MR, Breuer AC, Furlan AJ, Lederman RJ, Wilbourn AJ, Cosgrove DM, et al. Mechanism and frequency of brachial plexus injury in open-heart surgery: A prospective analysis. Ann Thorac Surg 1983;36:675–9.
15. Eng J, Wells FC. Morbidity following coronary artery revascularisation with the internal mammary artery. Int J Cardiol 1991;30:55–9.
16. Folliguet TA, Le Bret E, Moneta A, Musumeci S, Laborde F. Endoscopic saphenous vein harvesting versus 'open' technique. A prospective study. Eur J Cardiothorac Surg 1998;13:662–6.