Arrival Date: 15.01.2023 | **Published Date:** 30.07.2023 | **Vol:** 8, **Issue:** 3 | **pp:** 578-584 | **Doi Number:** http://doi.org/10.5281/zenodo.8207448

DETERMINING COMPLICATIONS IN PATIENTS UNDERGOING CORONARY ANGIOGRAPHY AND PERCUTANEOUS CORONARY INTERVENTION: A RETROSPECTIVE STUDY

KORONER ANJIYOGRAFI VE PERKÜTAN KORONER GIRIŞIM YAPILAN HASTALARDA GÖRÜLEN KOMPLIKASYONLARIN BELIRLENMESI: RETROSPEKTIF BIR ÇALIŞMA

Gülşah ÇAMCI [1], Betül BAYRAK [2], Sıdıka OĞUZ [1], Gamze BÜLBÜL [3], Fatih UZUN [4]

[1] Marmara University, Faculty of Health Sciences, Nursing Department, Nursing Department of Internal Medicine, Istanbul, Türkiye.
[2] Suleyman Demirel University, Faculty of Health Sciences, Department of Nursing, Department of Internal Medicine Nursing, Isparta, Türkiye.
[3]Başakşehir Çam and Sakura City Hospital, Istanbul, Türkiye.
[4] University of Health Sciences, Istanbul Mehmet Akif Ersoy Health Research Center For Thoracic, Cardiac and Vascular Surgery, Department of Cardiology, Istanbul, Türkiye.

ABSTRACT

Objective: This study was planned as a descriptive and retrospective study to determine the complications seen in patients undergoing coronary angiography and percutaneous coronary intervention.

Methods: The sample of the study included the data of all patients who underwent coronary angiography and percutaneous coronary intervention in a city hospital in Istanbul between May and November 2020. 529 individuals aged between 18-80 were included in the study.

Results: Mean age of individuals was 56.04±10.95. 81.1% had a chronic disease and 35.2% had heart disease. 33.8% had a family history of heart disease. 7% of them had previous myocardial infarction, 45.7% had previous coronary angiography and 28% had previous percutaneous coronary angioplasty. Contrast agent-related complications were found in 14.7%, major vascular complications in 10.8%, cerebrovascular complications in 2.6%, and renal complications in 4.2%. Major vascular complications were more common in women (p=0.041). Unemployed individuals had more contrast agent-related complications than employed individuals (p=0.032). Contrast agent-related complications were more common in individuals with chronic disease (p=0.015). Those with heart disease had more contrast agent-related complications (p=0.028), major vascular complications (p=0.003), and cerebrovascular complications (p=0.008).

Conclusion: Contrast agent-related and major vascular complications were found to be the most common during coronary angiography and intervention.

Keywords: Coronary angiography, Coronary angioplasty, Contrast agent, Renal complication, Vascular complication.

ÖZET

Amaç: Bu çalışma koroner anjiyografi ve perkütan koroner girişim yapılan hastalarda görülen komplikasyonların belirlenmesi amacıyla tanımlayıcı ve retrospektif bir çalışma olarak planlandı.

Gereç ve Yöntem: Çalışmanın örneklemini Mayıs 2020-Kasım 2020 tarihleri arasında İstanbul ilinde bulunan bir şehir hastanesinde koroner anjiyografi ve perkütan koroner girişim yapılan tüm hastaların verileri oluşturdu. Çalışmaya 18-80 yaş arasında olan 529 birey alındı.

Bulgular: Bireylerin yaş ortalaması 56,04±10,95 olduğu bulundu. Bireylerin %81,1'i bir kronik hastalığa sahipti. %33,8 bireyin ailede kalp hastalığı öyküsü bulunmaktaydı. %7 bireyin önceden miyokart infartüsü geçirdiği, %45,7 birey önceden koroner anjiyografi olduğu ve %28'nin önceden perkütan koroner anjiyoplasti olduğu bulundu. Bireylerin %14,7'sinde kontrast maddeye bağlı komplikasyonlar, %10,8'inde majör vasküler komplikasyonlar, %2,6'sında serebrovasküler komplikasyonlar ve %4,2'sinde renal komplikasyonlar olduğu saptandı. Çalışmada kadınlarda major vasküler komplikasyonlar daha fazla görüldü (p=0,041). Çalışmayan bireylerin kontrast maddeye bağlı komplikasyonları çalışan bireylere göre daha fazla olduğu bulundu (p=0,032). Kronik hastalığı olan bireylerde kontrast maddeye bağlı komplikasyonlar daha fazla görüldü (p==0,015). Kalp hastalığı olan bireylerin kontrast maddeye bağlı komplikasyonlar (p=0,028), Majör vasküler komplikasyonlar (p=0,003) ve serebrovasküler komplikasyonlar (p=0,008) daha fazla olduğu saptandı.

Sonuç: Koroner anjiyografi ve girişim sırasında en fazla kontrast madde ve major vasküler komplikasyonların olduğu saptandı.

Anahtar kelimeler: Koroner anjiyografi, Koroner anjiyoplasti, Kontrast madde, Renal komplikasyon, Vasküler komplikasyon.

Sorumlu Yazar / Corresponding Author: Gülşah ÇAMCI, Assistant Prof., Marmara University, Health Sciences Faculty, Nursing Department, Nursing Department of Internal Medicine, Istanbul, Türkiye. **E-mail:** gulsah.camci@marmara.edu.tr

Bu makaleye atıf yapmak için / Cite this article: Çamcı, G., Bayrak, B., Oğuz, S., Bülbül, G., & Uzun, F. (2023). Determining Complications in Patients Undergoing Coronary Angiography and Percutaneous Coronary Intervention: A Retrospective Study. *Gevher Nesibe Journal of Medical & Health Sciences, 8(3),578-584* http://doi.org/10.5281/zenodo.8207448

INTRODUCTION

Werner Forssmann was the first person to insert a catheter into the heart in 1929. Today, cardiac catheterization is routinely performed in hospitals all over the world (Ammann et al., 2003). Coronary angiography is the gold standard procedure for determining the extent and presence of atherosclerotic coronary artery disease. As with any invasive procedure, there may be patient-specific and procedural complications in coronary angiography and intervention. Complications range from minor problems with short-term sequelae to life-threatening situations that can cause irreversible damage if emergency care is not provided (Bayrak et al., 2019; Dinçkal & Okuyan, 2014; Oğuz & Çamcı, 2016; Oğuz, Erguvan, Ünal, Bayrak, & Çamcı, 2019; Tavakol, Ashraf, & Brener, 2012). Complications occurring during percutaneous coronary interventions and coronary angiography may differ depending on the patient, the operator performing the procedure, and the type of procedure performed (Dinçkal & Okuyan, 2014). Contrast agent-related reactions, major vascular complications, acute renal failure, and cerebrovascular accidents are the most common complications during percutaneous coronary intervention and coronary angiography (Abdollahi, Mehranfard, Behnampour, & Kordnejad, 2015). These complications prolong the hospital stay and increase mortality and morbidity in patients with suspected coronary artery disease (Bitargil, Başbuğ, Göçe, Günerhan, & Karakurt, 2014). Comprehensive analyzes of complications were performed in the 1980s and early 1990s, demonstrating relative mortality rates between 0.1% and 0.2%, and overall complication rates between 0.8% and 1.8%. However, very limited data are available on the procedural complications of diagnostic cardiac catheterization in the last 10 years (Ammann et al., 2003). Therefore, this study aimed to determine the complications in patients who underwent percutaneous coronary intervention and coronary angiography.

MATERIALS AND METHODS

Aim of the research

This study was planned as a descriptive and retrospective study to determine the complications seen in patients who underwent coronary angiography and percutaneous coronary intervention.

Research questions

What is the prevalence of complications in patients undergoing coronary angiography and percutaneous coronary intervention?

What is the incidence of coronary angiography and percutaneous coronary intervention complications according to the sociodemographic characteristics of the patients?

Population and Sample of the Research

The population and sample of the study included all patients who underwent coronary angiography and percutaneous coronary intervention between May 2020 and November 2020 in a City Hospital in Istanbul. The data of 529 individuals aged between 18-80 were included in the study.

Data Collection Tool

The patient information form and complications form were used for data collection. The patient information form included questions on sociodemographic details (age, gender, height-weight, education, occupation, economic status) and disease status (presence of chronic disease and heart disease, family history of heart disease, allergies, habits, drugs used, history of previous myocardial infarction, and history of previous angiography and percutaneous coronary intervention). The complications form included questions on contrast agent-related complications (itching, nausea, vomiting, dyspnoea, headache, etc.), major vascular complications (hematoma, pseudoaneurysm, dissection, spasm, etc.), cerebrovascular complications (cerebral embolism, bleeding, stroke, etc.), renal complications (acute renal failure), coronary artery dissection and perforation. Questions about complications can be answered as “Yes” and “No”, and the frequency of complications was evaluated based on these answers. The data of the study were collected retrospectively from the hospital archive by file scanning. The opinions of two experts were taken for the data collection form.

Statistical Evaluation of Data

IBM SPSS statistical software was used while evaluating the findings obtained in the study. The fit of the variables to the normal distribution was evaluated with the Shapiro-Wilks test. Descriptive statistical

methods (standard deviation, mean, frequency) were used when evaluating the study data. The Chi-square test, Fisher's exact chi-square test, and continuity (Yates) correction were used to evaluate the qualitative data. Statistical significance was set at $p<0.05$.

Ethical Aspect of the Study

Ethics committee approval was obtained for the study (Date: 04.12.2020, Protocol No: 09.2020.1277). The study adhered to the Helsinki Declaration of Human Rights.

RESULT

Table 1: Distribution of Sociodemographic Characteristics of the Participants (n=529)

Variables		n	%
Gender	Female	186	35.2
	Male	343	64.8
Education	Illiterate	52	9.8
	Literate	9	1.7
	Primary/Secondary	306	57.8
	High school	110	20.8
	Primary/Secondary	52	9.9
Age (Mean+SD=56.04±10.95)	20-34	11	2.1
	35-49	145	27.4
	50-64	249	47.1
	65 years and over	124	23.4
Employment status	Yes	316	59.7
	No	213	40.3
Economic Status	Not enough	202	38.2
	Just enough or more	327	61.8
Body mass İndex	Underweight (<18.5)	2	0.4
	Normal (18.5-24.99)	96	18.1
	Overweight (25.0-29.99)	202	38.2
	Obese (>30)	229	43.3
Chronic disease	Yes	429	81.1
	No	100	18.9
Heart disease	Yes	186	35.2
	No	343	64.8
Family history of heart disease	Yes	179	33.8
	No	350	66.2
History of Myocardial Infarction	Yes	37	7
	No	492	93
History of Coronary Angiography	Yes	242	45.7
	No	287	54.3
History of Percutaneous Coronary Intervention	Yes	148	28
	No	381	72

Of the participants, 64.8% were male, 57.8% were primary/secondary school graduates, 47.1% were aged between 50-64 years and their mean age was 56.04±10.95. 59.7% were employed, 61.8% had an income equal to/more than their expenses, 43.3% were obese and 38.2% were overweight. 81.1% had a chronic disease, 35.2% had heart disease, and 33.8% had a family history of heart disease. Seven percent of them had a previous myocardial infarction, 45.7% had previous coronary angiography and 28% had previous percutaneous coronary angioplasty (Table 1).

Table 2: Distribution of Complications in Coronary Angiography and Percutaneous Coronary Interventions (n=529)

Complications	n	%
Contrast agent-related complications	78	14.7
Major vascular complications	57	10.8
Cerebrovascular complications	14	2.6
Renal complications	22	4.2

Contrast agent-related complications were found in 14.7%, major vascular complications in 10.8%, cerebrovascular complications in 2.6%, and renal complications in 4.2% (Table 2).

Table 3: Comparison of Complications in Coronary Angiography and Percutaneous Coronary Interventions by socio-demographic variables (n=529)

		Contrast agent-related complications				**Major vascular complications**			
		Yes		**No**		**Yes**		**No**	
Variables		n	%	n	%	n	%	n	%
Gender	Female	34	18.3	152	81.7	27	14.5	159	85.5
	Male	44	12.8	299	87.2	30	8.7	313	91.3
		χ^2 =2.851; p=0.091				χ^2=4.176; **p=0.041**			
Employment	Yes	38	12	278	88	29	9.2	287	90.8
	No	40	18.8	173	81.2	28	13.1	185	86.9
		χ^2=4. 617; **p=0.032**				χ^2=2.084; p=0.149			
Economic Status	Not enough	37	18.3	165	81.7	23	11.4	179	88.6
	Just enough or more	41	12.5	286	87.5	34	10.4	293	89.6
		χ^2=3.317; p=0.069				χ^2=0.127; p=0.722			
Chronic disease	Yes	71	16.6	358	83.4	49	11.4	380	88.6
	No	7	7	93	93	8	8	92	92.4
		χ^2=5.884; **p=0.015**				χ^2=0.988; p=0.320			
Heart disease	Yes	36	19.4	150	80.6	30	16.1	156	83.9
	No	42	12.2	301	87.8	27	7.9	316	92.1
		χ^2=4.850; **p=0.028**				χ^2=8.553; **p=0.003**			
		Cerebrovascular complications				**Renal complications**			
		Yes		**No**		**Yes**		**No**	
		n	%	n	%	n	%	n	%
Gender	Female	8	4.3	178	95.7	9	4.8	177	95.2
	Male	6	1.7	337	98.3	13	3.8	330	96.2
		χ^2=3.048; p=0.93				χ^2=0.333; p=0.564			
Chronic disease	Yes	13	3	416	97	17	4	412	96
	No	1	1	99	99	5	5	95	95
		χ^2=1.297; p=0.255				χ^2=0.219; p=0.640			
Heart disease	Yes	10	5.4	176	94.6	10	5.4	176	94.6
	No	4	1.2	339	98.8	12	3.5	331	96.5
		χ^2=8.297; **p=0.008**				χ^2=1.067; p=0.362			

χ^2= Chi-Square Test

Major vascular complications were more common in women in the study (p=0.041). Unemployed individuals had more contrast agent-related complications than employed individuals (p=0.032). Contrast agent-related complications were more common in individuals with chronic disease (p==0.015). Those with heart disease had more contrast agent-related complications (p=0.028), major vascular complications (p=0.003), and cerebrovascular complications (p=0.008). There was no statistically significant relationship between economic status and complications (p>0.05) (Table 3).

DISCUSSION

Contrast agent-related complications were found in 14.7% of the participants (Table 2). In a study conducted in 176 hospitals across the country in the United States between 1973-74 years, the mortality rate due to coronary angiography was 0.14%, and the incidence of contrast agent reaction was quite high compared to previous years (Adams & Abrams, 1979). Contrast agent-induced neurotoxicity is a very rare condition and advanced age, male gender and hypertension are its major risk factors. Although the prognosis of contrast agent neurotoxicity is benign, it can potentially cause permanent neurological damage or death. One study found that patients with ophthalmic involvement had a higher propensity for permanent damage. The same study emphasized that the dose of the contrast agent used in coronary angiography was important (Kocabay et al., 2014). Recent studies examining the complication of contrast media are insufficient. Compared to existing studies, contrast agent complications were found to be higher in this study.

The prevalence of major vascular complications in the patients participating in this study was found to be 10.8%. In the study of Bitargil et al., the incidence of major vascular complications was determined as 3.7%. The physical examinations of 75 patients who developed vascular complications demonstrated swelling in the femoral region in 52, bleeding in the form of leakage at the intervention site in 21, increase in diameter and Homans positivity in the extremity in one, and pulselessness and coldness and pallor in the extremity in one patient (Bitargil et al., 2014). In another study, arterial obstruction, hemorrhage, and pseudoaneurysm were more common with transaxillary angiography than with transaxillary and tramslumber angiography (Hessel, Adams, & Abrams, 1981). Of the 250 patients who underwent radial angiography, five had failed radial attempts and five had arterial spasms (Hildick-Smith et al., 1998). In a meta-analysis, radial angiography and interventions had less major bleeding than femoral interventions. The radial intervention was found to reduce the length of hospital stay by 0.4 days and the risk of death tended to decrease as well (Jolly, Amlani, Hamon, Yusuf, & Mehta, 2009). In some studies, bleeding was seen as the most important vascular complication in coronary angiography and angioplasty (Bajraktari et al., 2021; Cantor et al., 2015; Erdem, Kurtoğlu, Küçük, İlgenli, & Kızmaz, 2021; Gayed, Yadak, Qamhia, Daralammouri, & Ohlow, 2017; Hahalis et al., 2016; Louvard, Lefevre, Allain, & Morice, 2001; Roghani-Dehkordi et al., 2018). Berry et al. emphasized that femoral hematoma occurred in 22% and 41% of coronary angiography and percutaneous coronary interventions, respectively (Berry, Kelly, Cobbe, & Eteiba, 2004). In this study, more major vascular complications were seen compared to other studies except for the study of Berry et al. It is thought that this may be due to the different location of the treated area (femoral, radial), the inability to apply compression after the procedure, the use of heparin, and the experience of the person doing the intervention.

The prevalence of cerebrovascular complications was found to be 2.6% in the patients in this study. Duraklı et al. reported that the prevalence of cerebrovascular complications increased up to 4% (Durakli, Yetimalar, Seçil, Öztürk, & Başoğlu, 2006). In a retrospective study, stroke was diagnosed in 100 of 650.674 coronary angiography patients and 57 of 526.487 percutaneous coronary interventions (Staszczak et al., 2021). Cerebrovascular complications after percutaneous coronary intervention, although rare, have been found to be associated with high rates of in-hospital death and acute renal failure, often requiring dialysis (Dukkipati et al., 2004). This study shows similar results to the studies above. Advanced age, renal failure, diabetes, hypertension, and a history of cerebrovascular accidents are thought to be important risk factors for the occurrence of cerebrovascular complications.

The prevalence of renal complications in the patients participating in this study was found to be 4.2%. In the Competence Guidelines in Interventional Cardiology published by the Turkish Society of Cardiology, the incidence of renal complications was determined to be between 10-40% (TKD, 2005). The prevalence of contrast nephropathy was found to be 42.5% in a prospective cohort study conducted in Cuba between January 2016 and July 2017. In the study, the risk of developing contrast nephropathy

was increased in patients with significant coronary occlusion (Hernández González, Soler Morejón, & Tamargo Barbeito, 2021). There were fewer renal complications in this study compared to other studies. It is thought that failure to provide hydration assistance to patients at risk before the procedure, existing dehydration, and previous renal problems are important in the development of renal complications in coronary angiography and angioplasty.

CONCLUSION

It was determined that complications associated with the contrast agent and major vascular complications were the most common ones during coronary angiography and percutaneous coronary intervention. Due vigilance should be taken for these complications before the procedure.

Conflict of interest

All authors declare that they have no competing interests.

Funding

No funding was received for this project.

REFERENCES

Abdollahi, A. A., Mehranfard, S., Behnampour, N., & Kordnejad, A. M. (2015). Effect of positioning and early ambulation on coronary angiography complications: a randomized clinical trial. *Journal of caring sciences, 4*(2), 125.

Adams, D., & Abrams, H. (1979). Complications of coronary arteriography: a follow-up report. *Cardiovascular radiology, 2*(2), 89-96.

Ammann, P., Brunner-La Rocca, H. P., Angehrn, W., Roelli, H., Sagmeister, M., & Rickli Md, H. (2003). Procedural complications following diagnostic coronary angiography are related to the operator's experience and the catheter size. *Catheterization and Cardiovascular Interventions, 59*(1), 13-18.

Bajraktari, G., Rexhaj, Z., Elezi, S., Zhubi-Bakija, F., Bajraktari, A., Bytyçi, I., . . . Henein, M. Y. (2021). Radial Access for Coronary Angiography Carries Fewer Complications Compared with Femoral Access: A Meta-Analysis of Randomized Controlled Trials. *Journal of clinical medicine, 10*(10), 2163.

Bayrak, B., Oğuz, S., Arslan, S., Candar, B., Keleş, S., Karagöz, B., & Akpınar, G. (2019). Determination of Perceived Stress in Patients with Myocardial Infarction. *Turk J Cardiovasc Nurs, 10*(23), 129-137.

Berry, C., Kelly, J., Cobbe, S. M., & Eteiba, H. (2004). Comparison of femoral bleeding complications after coronary angiography versus percutaneous coronary intervention. *The American journal of cardiology, 94*(3), 361-363.

Bitargil, M., Başbuğ, H., Göçe, r. H., Günerhan, Y., & Karakurt, A. (2014). Koroner Anjiyografi Sonucu Gelişen Vasküler Komplikasyonlara Yaklaşımlarımız. *Damar Cer Derd, 23*(3), 164-167.

Cantor, W. J., Mehta, S. R., Yuan, F., Džavík, V., Worthley, M., Niemelä, K., . . . Widimsky, P. (2015). Radial versus femoral access for elderly patients with acute coronary syndrome undergoing coronary angiography and intervention: insights from the RIVAL trial. *American heart journal, 170*(5), 880-886.

Dinçkal, M. H., & Okuyan, E. (2014). Serebrovasküler Komplikasyonlar ve Tedavisi. In K. C. & E. A.M (Eds.), *Tanıdan Girişime Perkütan Koroner İşlemler* (1 ed., pp. 349-354). İstanbul: Akademi Yayınevi.

Dukkipati, S., O'Neill William, W., Harjai Kishore, J., Sanders William, P., Deo, D., Boura Judith, A., . . . Kahn Joel, K. (2004). Characteristics of cerebrovascular accidents after percutaneous coronary interventions. *Journal of the American College of Cardiology, 43*(7), 1161-1167. doi:10.1016/j.jacc.2003.11.033

Durakli, M., Yetimalar, Y., Seçil, Y., Öztürk, N., & Başoğlu, M. (2006). Koroner Anjiyografi Sonrası Nörolojik Komplikasyon Gelişen Bir Olgu. *Journal of Neurological Sciences (Turkish), 23*(4), 322-325.

Erdem, K., Kurtoğlu, E., Küçük, M. A., İlgenli, T. F., & Kızmaz, M. (2021). Distal transradial versus conventional transradial access in acute coronary syndrome. *Turk Kardiyol Dern Ars, 49*(4), 257-265.

Gayed, M., Yadak, N., Qamhia, W., Daralammouri, Y., & Ohlow, M.-A. (2017). Comorbidities and Complications in Nonagenarians Undergoing Coronary Angiography and Intervention Tertiary Center Analysi. *International heart journal*, 16-083.

Hahalis, G., Tsigkas, G., Kakkos, S., Panagopoulos, A., Tsota, I., Davlouros, P., . . . Christodoulou, I. (2016). Vascular complications following transradial and transulnar coronary angiography in 1600 consecutive patients. *Angiology, 67*(5), 438-443.

Hernández González, A., Soler Morejón, C., & Tamargo Barbeito, T. O. (2021). Contrast-induced nephropathy associated factors in patients with significant coronary obstruction. *İnternational Journal of Medical and Surgical Sciences, 8*(3), 1-11. doi:https://doi.org/10.32457/ijmss.v8i3.1567

Hessel, S. J., Adams, D. F., & Abrams, H. L. (1981). Complications of angiography. *Radiology*, *138*(2), 273-281.

Hildick-Smith, D. J., Lowe, M. D., Walsh, J. T., Ludman, P. F., Stephens, N. G., Schofield, P. M., . . . Petch, M. C. (1998). Coronary angiography from the radial artery–experience, complications and limitations. *International journal of cardiology*, *64*(3), 231-239.

Jolly, S. S., Amlani, S., Hamon, M., Yusuf, S., & Mehta, S. R. (2009). Radial versus femoral access for coronary angiography or intervention and the impact on major bleeding and ischemic events: a systematic review and meta-analysis of randomized trials. *American heart journal*, *157*(1), 132-140.

Kocabay, G., Karabay, C., Kalayci, A., Akgun, T., Guler, A., Oduncu, V., . . . Kirma, C. (2014). Contrast-induced neurotoxicity after coronary angiography. *Herz*, *39*(4), 522-527.

Louvard, Y., Lefevre, T., Allain, A., & Morice, M. C. (2001). Coronary angiography through the radial or the femoral approach: the CARAFE study. *Catheterization and Cardiovascular Interventions*, *52*(2), 181-187.

Oğuz, S., & Çamcı, G. (2016). Coronary Artery Disease and Occupational Life *Journal of Cardiovascular Nursing*, *7*(12), 15-23.

Oğuz, S., Erguvan, B., Ünal, G., Bayrak, B., & Çamcı, G. (2019). Determination of Klowledge of Cardiovasculer Disease Risk Factors Among University Students. *MN kardiyoloji*, *26*(3), 184-191.

Roghani-Dehkordi, F., Mansouri, R., Khosravi, A., Mahaki, B., Akbarzadeh, M., & Kermani-Alghoraishi, M. (2018). Transulnar versus transradial approach for coronary angiography and angioplasty: Considering their complications. *ARYA atherosclerosis*, *14*(3), 128.

Staszczak, B., Malinowski, K., Siudak, Z., Wanha, W., Surdacki, A., Wojakowski, W., . . . Januszek, R. (2021). Frequency and predictors of coronary angiography and percutaneous coronary intervention related stroke. *European Heart Journal*, *42*(Supplement_1), ehab724. 2153.

Tavakol, M., Ashraf, S., & Brener, S. J. (2012). Risks and complications of coronary angiography: a comprehensive review. *Global journal of health science*, *4*(1), 65.

TKD. (2005). A Competency Guide in Interventional Cardiology of Turkish Society of Cardiology. *Turk Kardiyol Dern Ars*, *33*(1), 28-68.