¹ Cardiovascular Diagnosis and Intervention
Unit, Clínica Girassol, Luanda, Angola.

Primary angioplasty in acute myocardial infarction: initial experience in a developing country

Angioplastia primária em infarto agudo do miocárdio: experiência inicial de um país em desenvolvimento

Miguel Bernardino Antunes Vicente^{1ID}, Roger Ravelo Dopico^{1ID},
Luís Mariano de Lima Domingos^{1ID}, Tomás Carlos Méndez Peralta^{1ID},
Valdano Manuel^{1ID}, Júlio César Echarte Martinez^{1ID}, Leonardo Hipólito López Ferrero^{1ID},
Jesus del Todo^{1ID}, Abel Salas Fabre^{1ID}, Ramon Reynoso^{1ID}, Vasco Sabino da Silva^{1ID},
António Pedro Filipe Júnior^{1ID}

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ABSTRACT – Background: Coronary artery disease is a major public health concern worldwide. In Africa, varying rates of progression increased in different countries. In Angola, although the epidemiological scenario is dominated by infectious diseases, the prevalence of coronary artery disease is increasing with notable impacts, requiring the creation of mechanisms to face this reality in a country where lack of specific infrastructure is still a challenge. The objective of this study was to describe the experience of primary angioplasty in patients with acute myocardial infarction in an Angolan tertiary care center. **Methods:** This was a descriptive, longitudinal, retrospective study, involving 165 patients diagnosed with acute myocardial infarction between 2012 and 2019. Variables were age, sex, risk factors, angiographic and procedure-related characteristics, and main complications. **Results:** The mean age was 58.3±6.8 years, and males predominated (75.8%). Hypertension (69.7%), dyslipidemia (35.2%), smoking (32.7%) and diabetes (29.7%) were more prevalent. The anterior location was the predominant topography of infarction (49.7%). Single vessel disease was the most common pattern (50.9 %). The left anterior descending artery was the most often involved vessel (49.7%). The door-to-balloon time was 46.6±32.4 minutes. In the multivariate analysis, anterior myocardial infarction (p=0.033), diabetes (p=0.004), age ≥60 years (p≤0.001) and post-coronary intervention final TIMI flow <III (p≤0.001) were independent predictors of unfavorable outcomes. **Conclusion:** Percutaneous coronary intervention in the context of acute myocardial infarction in Angola is a reality, but the number of procedures performed is not enough given the current great demand.

Keywords: Angioplasty; Acute myocardial infarction; Coronary artery disease; Angola

RESUMO – Introdução: A doença aterosclerótica coronariana representa um importante problema de saúde pública mundialmente. Na África, suas taxas variáveis de progressão têm aumentado em diferentes países. Em Angola, apesar do domínio do cenário epidemiológico pelas doenças infectocontagiosas, a doença aterosclerótica coronariana vem crescendo com notáveis impactos, forçando a criação de mecanismos para enfrentar essa realidade em um país onde a escassez de infraestrutura específica ainda é um desafio. O objetivo deste estudo foi descrever a experiência de angioplastia primária em pacientes com infarto agudo do miocárdio em um centro terciário angolano. **Métodos:** Estudo descritivo, longitudinal, retrospectivo, com envolvimento de 165 pacientes diagnosticados com infarto agudo do miocárdio entre 2012 e 2019. As variáveis foram idade, sexo, fatores de risco, características angiográficas e relacionadas com o procedimento e suas principais complicações. **Resultados:** A média de idade foi de 58,3±6,8 anos, e predominou o sexo masculino (75,8%). Hipertensão arterial (69,7%), dislipidemia (35,2%), tabagismo (32,7%) e diabetes (29,7%) foram mais prevalentes. A localização em parede anterior foi predominante (49,7%). Houve majoritariamente comprometimento de um vaso (50,9 %). A artéria descendente anterior foi a mais envolvida (49,7%). O tempo porta-balão foi de 46,6±32,4 minutos. Na análise multivariável, infarto de parede anterior (p=0,033), diabetes (p=0,004), idade ≥60 anos (p≤0,001) e fluxo TIMI final pós-intervenção coronária <III (p≤0,001) foram preditores independentes para desfechos desfavoráveis. **Conclusão:** A intervenção coronária percutânea no contexto do infarto agudo do miocárdio em Angola é uma realidade, porém não é suficiente diante da grande demanda atual.

Descritores: Angioplastia; Infarto agudo do miocárdio; Doença da artéria coronária; Angola

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Corresponding author:

Miguel Bernardino Antunes Vicente
Rua Comandante Gika, 225 – Alvalade –
Maianga - Luanda, Angola
E-mail: miguelantunesv@gmail.com

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INTRODUCTION

Angola is an African country located in southern Africa, with a territorial extension of about 1,246,700km² and a population of approximately 35 million inhabitants.¹ It is an epidemiological stage dominated by infectious diseases, where the incidence of coronary artery disease (CAD) has slowly increased, with drastic impacts on the population.² This increase may be explained by changes in lifestyle, rapid urbanization and conditions that lead to a fast epidemiological transition, bringing with them an increased prevalence of cardiovascular risk factors and higher morbidity and mortality rates from acute myocardium infarction (MI),³ in a scenario in which difficult access to diagnostic and treatment services and lack of specialized professionals interfere in its greater notoriety. This limits the real understanding of the disease, availability of better statistical data and, consequently, the creation of specific health policies.^{3,4} Coronary artery disease accounts for about 18 million deaths in the world annually, and 80% of these deaths occur in low- and middle-income countries. It is estimated that, by 2030, CAD will account for about 30 million deaths.⁵

Percutaneous coronary intervention (PCI) is the preferred reperfusion strategy, in the initial approach to patients with ST-segment elevation MI (STEMI), with high success rates.^{6,7} This is still a great challenge in Angola and in most African countries, due to the lack of specific policies aimed to improve the health scenario, leaving thousands of people with no access to a treatment considered ideal worldwide.^{8,9}

The context of acute MI in Angola is not clear. Therefore, our objective was to report the initial primary angioplasty data from an Angolan private tertiary care hospital.

METHODS

This was a descriptive, longitudinal, retrospective study, conducted at the Cardiovascular Diagnosis and Intervention Unit, of *Clínica Girassol*, in Luanda, Angola. All patients diagnosed with STEMI between 2012 and 2019, of both sexes, who underwent PCI in an emergency context were included in the study. Patients with non-ST elevation MI and those who underwent elective procedures were excluded. All patients signed the Informed Consent Form for the procedure and for participating in the research.

The variables used were sex, age, risk factors, topography of infarction, the artery involved, access route and complications. The results were presented in the form of tables, in absolute and percentage values.

Statistical analysis

The analyses were performed using the software Statistical Package for the Social Sciences (SPSS), version

12.0. The categorical variables were presented as absolute and relative frequencies; the continuous variables were presented as mean±standard deviation, or median and 25% and 75% percentiles, depending on whether they followed normal distribution or not. The Wald and the Fischer tests were applied. The categorical variables were compared between groups using the Chi-squared test. A multivariate analysis was performed to define the prognostic factors related to complications.

RESULTS

Our study included 165 patients of both sexes diagnosed with STEMI. There was a predominance of individuals aged between 51 and 60 years, with a mean age of 58.3±6.8 years, and a predominance of males (75.8%).

Regarding the risk factors of patients studied according to sex, the most prevalent were hypertension, dyslipidemia, smoking, and diabetes mellitus (DM) (69.7%; 35.2%; 32.7% and 29.7%, respectively), with a significant predominance of male dyslipidemia patients (32.7% *versus* 2.4%; $p \leq 0.01$) and smokers (28.5% *versus* 4.2; $p = 0.03$). Anterior wall acute MI was the predominant clinical presentation (49.7%), and the left anterior descending artery (LAD) was the most affected (64.8%) and frequently involved vessel in most STEMIs (49.7%). The femoral access was the preferred route (75.8%). The average door-to-balloon time was 46.6±32.4 minutes, with longer delays among women (61.9±72.0 minutes) when compared to men (31.2±61.9 minutes). Mortality rate was 2.42%, with a significant difference for women when compared to men (1.8% *versus* 0.60%; $p = 0.016$). In the multivariate analysis, the variables that could be related to the occurrence of the aforementioned adverse events were included. The anterior wall location was an independent predictor for the occurrence of adverse events ($p = 0.033$; B-exponential: 7.803; lower limit: 1.203; upper limit: 39.500) (Tables 1 to 7).

Table 1. Patients according to sex and age group

Age group (years)	Sex	
	Male	Female
≤40	6.1	0.0
41-50	13.3	1.8
51-60	31.5	7.3
61-70	19.4	6.1
71	5.5	9.1

Results expressed by %. Calculation based on total number of patients: n=165 corresponded to 100%.

Table 2. Risk factors according to sex

Clinical characteristics	Sex		p-value
	Male	Female	
Hypertension*	50.3	19.4	0.15
DM*	23.0	6.7	0.88
Dyslipidemia*	32.7	2.4	<0.01
Obesity†	6.1	1.8	0.61
Smoking*	28.5	4.2	0.03
Prior MI*	12.1	4.8	0.73
Prior PCI†	2.4	1.2	0.63

Results expressed by %. Calculation based on total number of patients: n=165 corresponded to 100%.

*Chi-squared test; †Fischer's test.

DM: *diabetes mellitus*; MI: myocardial infarction; PCI: percutaneous coronary intervention.

Table 3. Topography of infarction and sex

Topography	Sex		p-value
	Male	Female	
Anterior	38.2	11.5	0.199
Inferior	32.1	12.1	
Lateral	5.5	0.6	

Results expressed by %. Calculation based on total number of patients: n=165 corresponded to 100%. As a statistical test to determine the statistical significance, the Chi-squared test was applied.

Table 4. Angiographic characteristics according to sex

Characteristic	Sex		p value
	Male	Female	
CAD $\geq$ 50%*/vessels			0.99
No lesions	1.8	0.6	
1 vessel	38.2	12.7	
2 vessels	24.2	7.3	
3 vessels	11.5	3.6	
Vessels			
LMCA	2.8	0.2	0.81
LAD†	50.9	13.9	0.60
LCx†	30.3	9.1	0.92
RCA†	38.8	15.2	0.29
CTO‡/vessels			
LAD†	1.2	0.0	1.00
LCx†	4.8	0.0	0.20
RCA†	3.6	1.8	0.45
Access route*			
Femoral	56.4	19.4	0.69
Radial	18.8	4.8	
Other	0.6	0.0	
Pre-PCI TIMI*			
0	54.5	17.0	0.65
I	13.3	2.4	
II	5.5	4.8	
III	2.4	0.0	
Management*			
Medical treatment	6.1	3.0	0.65
PCI	66.7	20.0	
CABG	3.0	1.2	

Results expressed by %. Calculation based on total number of patients: n=165 corresponded to 100%.

*Chi-squared test; †Chi-squared test with correction; ‡ Fisher's exact test.

CAD: coronary artery disease; LMCA: left main coronary artery; LAD: left anterior descending artery; LCx: left circumflex artery; RCA: right coronary artery; CTO: chronic total occlusion; PCI: percutaneous coronary intervention; ; TIMI: Thrombolysis in Myocardial Infarction; CABG: coronary artery bypass graft.

Table 5. Coronary intervention-related characteristics and sex

Characteristic	Sex		p-value
	Male	Female	
Infarction culprit artery*			
LAD	38.2	11.5	0.26
LCx	10.3	1.2	
RCA	26.1	11.5	
Door-to-balloon time	31.2±61.9	61.9±72.0	0.96
Direct stent†	37.0	12.7	0.82
Balloons, mm			
Diameter	1.2±1.2	1.1±1.2	0.76
Length	8.4±8.6	8.4±8.9	0.86
Drug-eluting stent (mean)	1.3	0.9	0.81
Drug-eluting stent/patients			
1	41.8	13.4	0.84
2	25.4	7.5	
$\geq$ 3	9.0	3.0	
Drug-eluting stent, mm			
Diameter	2.9±0.3	2.9±0.6	0.86
Length	18.2±4.3	18.1±4.7	0.44
Implantation pressure (atm)	13.96±5.5	13.47±5.4	0.15
Post-PCI TIMI*			
0	8.5	1.2	0.32
I	2.4	1.2	
II	4.2	3.0	
III	60.69	18.8	

Results expressed as % or mean±standard deviation. As a statistical test to determine the significance of the comparisons of means, the Wilcoxon test was applied. Calculation based on total number of patients: n=165 corresponded to 100%.

*Chi-squared test; †Chi-squared test with correction.

LAD: left anterior descending artery; LCx: left circumflex artery; RCA: right coronary artery; PCI: percutaneous coronary intervention; TIMI: Thrombolysis in Myocardial Infarction.

Table 6. Complications according to sex

Complications	Sex		p-value
	Male	Female	
Death	0.60	1.8	0.016
Heart failure	5.45	3.64	0.136
Arrhythmias	3.64	2.42	0.232
Coronary dissection	1.82	0.60	1.582
Hematomas	0.60	0.0	0.573
No reflow	4.85	1.21	0.749
Acute thrombosis	0.60	0.60	0.395

Results expressed as %. As statistical proof to determine significance, the Fischer's exact test was applied. Calculation based on total number of patients: n=165 corresponded to 100%.

Table 7. Multivariate analysis for occurrence of adverse events

Variables	Wald	p-value	(B)-Exponential	95%CI for B-exponential	
				Lower limit	Upper limit
Anterior wall	1.060	0.033	7.803	1.203	39.500
Hypertension	4.059	0.074	2.723	1.008	45.671
DM	2.079	0.004	8.701	2.045	42.333
Smoking	5.600	0.089	1.762	0.003	11.255
Male	4.809	1.200	1.700	0.900	10.650
Age ≥60 years	3.407	<0.001	9.088	2.400	37.055
Post-PCI TIMI <III	5.500	<0.001	7.700	0.100	33.300

DM: diabetes mellitus; TIMI: Thrombolysis in Myocardial Infarction; PCI: percutaneous coronary intervention.

DISCUSSION

This was the first Angolan study on the profile of patients with STEMI treated by primary PCI, and the results are corroborated by most registries from several countries, where patients with this medical condition are managed using this treatment modality, considered the preferred one for reperfusion.^{6,9,10}

There was a predominance of male individuals treated by PCI, especially those in full active and productive phase of life, and hypertension stood out significantly as the most important risk factor. This data does not differ from the reality of other African countries,^{3,4,6,8} which show a strong association between risk factors and the occurrence of acute MI.^{11,12}

In Angola, several publications on the topic of risk factors are unanimous in highlighting hypertension as the main one, especially in individuals of lower socioeconomic status, and its association with smoking, DM, alcoholism and dyslipidemia could explain the higher prevalence and, consequently, the gradual increase in the incidence of acute MI in Angola.^{3,13,14}

Regarding the topographic location of acute MI, there is a discrepancy among the different studies consulted. In this investigation, 49.7% of patients presented anterior wall involvement, with no significant difference regarding sex (38.2% versus 11.5%; $p=0.199$). This finding could be explained by a greater involvement of the LAD in the patients studied (64.8%). On the other hand, divergent data from African studies conducted in patients with acute MI, treated by PCI, revealed most patients had involvement of the inferior wall.^{4,15}

Single-vessel CAD was the most prevalent angiographic characteristic, with no significant difference regarding sex (38.2% versus 12.7%; $p=0.99$). A South African study reported most patients had multivessel disease (42%) and the incidence of single vessel injury was 36%.¹⁶ In another African study, CAD was observed in 56% of patients with infarction treated by PCI.⁴ In Angola, there are few epide-

miological data to compare with this finding, but it may be inferred they would be similar to those reported in other parts of the world.^{4,10,15,17}

The femoral approach was preferably used (75.8%), followed by transradial access (23.6%). Similar data were published in a study carried out in Côte d'Ivoire, in which most patients undergoing PCI were approached via the femoral route.⁴ In Senegal, different data were reported, and the transradial access being the most used approach, demonstrating this route is gradually becoming popular in various work groups in Africa.⁷ Although the superiority of transradial access over the femoral access is proven, in addition to the undeniable benefits to patients, the femoral route is a priority among more experienced operators.^{18,19} In Angola, in recent years, the trend has been the use of transradial access for PCI, which is associated with lower rates of complications, mortality and shorter hospital stay, especially in patients with acute MI.²⁰

Reducing the delay in the first medical contact remains one of the great challenges in Angola; however there is a need to address some aspects that decisively influence the context of delay for patients in the country, making this an "Achilles heel" in our daily practice, a fact that was reflected in this investigation, with inadmissible delays for patients. This very important aspect involves multiple factors (economic, cultural, population education, deficiencies in intra- and extra-hospital structure, untrained professionals, means of transport, low accessibility conditions) and delays the early arrival of patients to the few existing referral centers.³ The times mentioned in this investigation were unacceptably long, with longer delays among women, coinciding with the literature.²¹ This could be explained by inadequate identification/valuation of symptoms in this group of patients, in addition to the factors already mentioned.²¹ In this sense, a recently published study evaluated the impact of sex and door-to-balloon times in patients with acute MI, revealing longer times for women, which was fundamental for explaining their worse outcomes.^{21,22} In most of the African countries,

the factors described underlie the rationale for failure in complying with this reality. Studies published in countries in the region reported their door-to-balloon times ranging from 52 hours to 4 days, far from what is recommended by the guidelines.^{7,10} Therefore, the urgent creation of joint and standardized strategies at all stages of care to approach patients with acute MI, in a timely manner, may be the beginning of a breakthrough in the care of these patients in Africa.^{4,23,24}

In the multivariate analysis, AMI of anterior wall (lower limit: 1.203; upper limit: 39.500; $p=0.033$; B-exponential: 7.803), DM (lower limit: 2.045; upper limit: 42.333; $p=0.004$; B-exponential: 8.701), advanced age (lower limit: 2.400; upper limit: 37.055; $p<0.001$; B-exponential: 9.088) and post-PCI TIMI <III were independent predictors of complications, impacting mortality of the patients studied (2.42%). These findings were similar to those reported worldwide, and it could be said that this Angolan population affected by MI has characteristics similar to those observed in the rest of the world.^{15,25,26}

CONCLUSION

Percutaneous coronary intervention, in the context of acute myocardial infarction in Angola, is a reality. However, discussing a primary percutaneous coronary intervention approach *per se* is controversial, due to the various situations described, which contradict the good practices recommended by current guidelines. Angola is far from having indicators comparable to world standards; for this to happen, there must be investments in training of professionals and creation of specific technical infrastructure. In clinical terms, it is clear that acute myocardial infarction is a concerning and still underdiagnosed condition in this environment. This study was an attempt to draw attention to the dimension of the problem, and to open perspectives for a better comprehensive approach to management of our patients.

SOURCE OF FINANCING

None.

DECLARATION OF CONFLICTS OF INTEREST

The authors declare having no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: MBAV, VM and RRD; data collection: MBAV and RRD; data interpretation: JE, LF and JT; text writing: LMLD, ASF and RR; approval of the final version to be published: VSS, APFJ and TCMP.

REFERENCES

1. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2019 Revision: African Countries by population (2021). [cited 2021 Sep 15]. Available from: <https://www.worldometers.info/world-population/angola-population/>
2. Angola. Ministério da Saúde (MINSA). Direção Nacional de Saúde Pública, Relatório Anual de Actividade; 2017. Angola: MINSA; 2017.
3. Peralta TM, Mariano L, Filipe Júnior AP, Azevedo L. Management of acute coronary syndrome (ACS) in Clinica Girassol in Luanda (Angola). *EC Cardiology*. 2019;6:146-54.
4. Ekou A, Yao H, Kouamé I, Boni RY, Ehouman E, N'Guetta R. Primary PCI in the management of STEMI in sub-Saharan Africa: insights from Abidjan Heart Institute catheterisation laboratory. *Cardiovasc J Afr*. 2020;31(4):201-4. <https://doi.org/10.5830/CVJA-2020-012>
5. Organização Pan Americana de Saúde (OPAS). Doenças cardiovasculares. [citado em 2021 Set. 21]. Disponível em: <https://www.paho.org/pt/topicos/doencas-cardiovasculares>
6. Puymirat E, Simon T, Cayla G, Cottin Y, Elbaz M, Coste P, et al.; USIK, USIC 2000, and FAST-MI investigators. Acute Myocardial Infarction: Changes in Patient Characteristics, Management, and 6-Month Outcomes Over a Period of 20 Years in the FAST-MI Program (French Registry of Acute ST-Elevation or Non-ST-Elevation Myocardial Infarction) 1995 to 2015. *Circulation*. 2017;136(20):1908-19. <https://doi.org/10.1161/CIRCULATIONAHA.117.030798>
7. Collet JP, Thiele H, Barbato E, Barthélémy O, Bauersachs J, Bhatt DL, et al.; ESC Scientific Document Group. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. 2021;42(14):1289-367. <https://doi.org/10.1093/eurheartj/ehaa575>. Erratum in: *Eur Heart J*. 2021;42(19):1908. Erratum in: *Eur Heart J*. 2021;42(19):1925. Erratum in: *Eur Heart J*. 2021 May 13; PMID: 32860058.
8. Bahiru E, Temu T, Gitura B, Farquhar C, Huffman MD, Bukachi F. Presentation, management and outcomes of acute coronary syndrome: a registry study from Kenyatta National Hospital in Nairobi, Kenya. *Cardiovasc J Afr*. 2018;29(4):225-30. <https://doi.org/10.5830/CVJA-2018-017>
9. Desta DM, Nedi T, Hailu A, Atey TM, Tsadik AG, Asgedom SW, et al. Treatment outcome of acute coronary syndrome patients admitted to Ayder Comprehensive Specialized Hospital, Mekelle, Ethiopia; A retrospective cross-sectional study. *Plos One*. 2020; 15(2):e0228953.
10. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al.; ESC Scientific Document Group. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). *Eur Heart J*. 2018;39(2):119-77. <https://doi.org/10.1093/eurheartj/ehx393>
11. Roth GA, Huffman MD, Moran AE, Feigin V, Mensah GA, Naghavi M, et al. Global and regional patterns in cardiovascular mortality. *Circulation*. 2015;132:1667-78. <https://doi.org/10.1161/CIRCULATIONAHA.114.008720>
12. Carrión-Chambilla M, Peña LB, Pinto-Concha J, Postigo-Díaz R. Características clínicas y seguimiento a 30 días de pacientes con síndrome isquémico coronario agudo. *Revista de la Sociedad Peruana de Medicina Interna*. 2007 [cited 2021 Sep 15];20(2):53-9. Available from: <http://revistamedicinainterna.net/index.php/spmi/article/view/284>
13. Capingana DP, Magalhães P, Silva AB, Gonçalves MA, Baldo MP, Rodrigues SL, et al. Prevalence of cardiovascular risk factors and

- socioeconomic level among public-sector workers in Angola. *BMC Public Health*. 2013;13:732. <https://doi.org/10.1186/1471-2458-13-732>
14. Paquissi FC, Manuel V, Manuel A, Mateus GL, David B, Béu G, et al. Prevalence of cardiovascular risk factors among workers at a private tertiary center in Angola. *Vasc Health Risk Manag*. 2016;12:497-503. <https://doi.org/10.2147/VHRM.S120735>
 15. Dioum M, Ndiaye PN, Aw F, Mingou JS, Bamba Ndiaye M, Antoine Sarr S, et al. Percutaneous coronary intervention in acute coronary syndromes with ST-segment elevation: prospective study about 54 cases collected at the Center of Interventional Cardiology of Aristide Le Dantec Hospital of Dakar. *Cardiol Vasc Res (Wilmington)*. 2019;3(4):1-5. <https://doi.org/10.33425/2639-8486.1054>
 16. Pillay AK, Naidoo DP. Atherosclerotic disease is the predominant aetiology of acute coronary syndrome in young adults. *Cardiovasc J Afr*. 2018;29(1):36-42. <https://doi.org/10.5830/CVJA-2017-035>
 17. Cengel A, Tanindi A. Myocardial infarction in the young. *J Postgrad Med*. 2009;55(4):305-13. doi: <https://doi.org/10.4103/0022-3859.58944>
 18. Barranco D, Artucio C. Angioplastia primaria en el infarto agudo del miocardio: diferencias según el género. Subestudio de la casuística uruguaya (2004-2012). *Rev Urug Cardiol*. 2017 [cited 2021 Sep. 15]:32:141-9. Available from: http://www.scielo.edu.uy/scielo.php?script=sci_arttext&pid=S1688-04202017000200141
 19. Hinohara TT, Rao SV. Current state of radial artery catheterization in ST-elevation myocardial infarction. *Prog Cardiovasc Dis*. 2015;58(3):241-6. <https://doi.org/10.1016/j.pcad.2015.07.007>
 20. Bauer T, Hochadel M, Brachmann J, Schächinger V, Boekstegers P, Zrenner B, et al.; Arbeitsgemeinschaft leitende kardiologische Krankenhausärzte (ALKK). Use and outcome of radial versus femoral approach for primary PCI in patients with acute ST elevation myocardial infarction without cardiogenic shock: results from the ALKK PCI registry. *Catheter Cardiovasc Interv*. 2015;86 Suppl 1:S8-14. <https://doi.org/10.1002/ccd.25987>
 21. Karkabi B, Meir G, Zafrir B, Jaffe R, Adawi S, Lavi I, et al. Door-to-balloon time and mortality in patients with ST-elevation myocardial infarction undergoing primary angioplasty. *Eur Heart J Qual Care Clin Outcomes*. 2021;7(4):422-6. <https://doi.org/10.1093/ehjqcco/qcaa037>
 22. Puymirat E, Caudron J, Steg PG, Lemesle G, Cottin Y, Coste P, et al.; FAST-MI investigators. Prognostic impact of non-compliance with guidelines-recommended times to reperfusion therapy in ST-elevation myocardial infarction. The FAST-MI 2010 registry. *Eur Heart J Acute Cardiovasc Care*. 2017;6(1):26-33. doi: <https://doi.org/10.1177/2048872615610893>
 23. Mboup MC, Diaio M, Dia K, Fall PD. Les syndromes coronaires aigus à Dakar: aspects cliniques thérapeutiques et évolutifs. *Pan Afr Med J*. 2014;19:126. <https://doi.org/10.11604/pamj.2014.19.126.3155>
 24. Yameogo NV, Samadoulougou A, Millogo G, Kologo KJ, Kombassere K, Toguyeni BJ, et al. [Delays in the management of acute coronary syndromes with ST-ST segment elevation in Ouagadougou and factors associated with an extension of these delays: a cross-sectional study about 43 cases collected in the CHU-Yalgado Ouédraogo]. *Pan Afr Med J*. 2012;13:90. French. PMID: 23396976.
 25. Shahzad K, Ali J, Ahmad A, Usman A, Rashdi A, Shafiq F. Outcome of primary percutaneous coronary intervention in patients with acute ST-segment elevation myocardial infarction who arrives at the heart center of the army in lahore. *Pak Armed Forces Med J*. 2021;70 Suppl-4:S781-6. <https://doi.org/10.51253/pafmj.v70iSuppl-4.6024>
 26. Elakabawi K, Huang X, Shah SA, Ullah H, Mintz GS, Yuan Z, et al. Predictors of suboptimal coronary blood flow after primary angioplasty and its implications on short-term outcomes in patients with acute anterior STEMI. *BMC Cardiovasc Disord*. 2020;20(1):391. <https://doi.org/10.1186/s12872-020-01673-0>