



## Coronary arteriography with radial access in coronary acute disease and its relation with handgrip strength and radial artery permeability (CARHANG)

*Arteriografía coronaria con acceso radial en la enfermedad coronaria aguda y su relación con la fuerza de agarre y la permeabilidad de la arteria radial (CARHANG)*

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### Keywords:

Handgrip, acute coronary syndrome, vascular, coronary angiography, radial artery, vascular access, vascular complications.

### Palabras clave:

Fuerza de agarre, síndrome coronario agudo, vascular, angiografía coronaria, arteria radial, acceso vascular, complicaciones vasculares.

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### ABSTRACT

**Introduction:** Little research has been conducted on some complications secondary to radial access for coronary arteriography in patients with ACS, such as loss of handgrip strength and radial flow alteration. These are not routinely evaluated, unaware that they may compromise the performance of trades that require fine skills or activities in daily life. **Material and methods:** Prospective observational longitudinal cohort study, a sample of 77 patients diagnosed with ACS, undergoing radial access to coronary arteriography. For data analysis, we used the IBM SPSS® V.21 statistical package. We used a Saehan Corporation® brand hydraulic dynamometer for the force measurement, and we performed a comparative analysis of related samples; t-Student test and binary logistic regression. **Results:** Proportion according to gender was 48.1% women and 51.9% men, the median age of 66 years (58-72). In the handgrip strength of patients with radial access, we found a statistically significant difference between the initial and final measurement  $p < 0.001$  (IC 95%: 1.59-4.07). **Conclusions:** We found a significant loss of handgrip strength in both genders, with lower than optimal force values for IADL, findings so far explained by the type of intervention that requires future studies.

### RESUMEN

**Introducción:** Se han realizado pocas investigaciones sobre algunas complicaciones secundarias al acceso radial para la arteriografía coronaria en pacientes con SCA, como la pérdida de fuerza de prensión y la alteración del flujo radial. Estos no se evalúan de forma rutinaria, sin saber que pueden comprometer el desempeño de los oficios que requieren habilidades finas o actividades en la vida diaria. **Material y métodos:** Estudio prospectivo observacional de cohorte longitudinal, con una muestra de 77 pacientes con diagnóstico de SCA, sometidos a coronariografía de acceso radial. Para el análisis de los datos, se utilizó el paquete estadístico IBM SPSS® V.21. Para la medición de la fuerza se utilizó un dinamómetro hidráulico de la marca Saehan Corporation® y se realizó un análisis comparativo de muestras relacionadas; prueba t-Student y regresión logística binaria. **Resultados:** La proporción por sexo fue de 48.1% mujeres y 51.9% hombres, la mediana de edad fue 66 años (58-72). En la fuerza de agarre de los pacientes con acceso radial, encontramos una diferencia estadísticamente significativa entre la medición inicial y final  $p < 0.001$  (IC del 95%: 1.59-4.07). Teniendo en cuenta los criterios de discapacidad para las actividades instrumentales de la vida diaria (IADL), realizamos un análisis estratificado, encontrando diferencias significativas por género ( $p < 0.05$ ). **Conclusiones:** Se encontró una pérdida significativa de fuerza de agarre en ambos sexos, con valores de fuerza menores al óptimo para IADL, hallazgos hasta ahora explicados por el tipo de intervención que requiere estudios futuros.

### INTRODUCTION

Currently, cardiovascular diseases are the leading cause of morbidity and mortality

in the world. In 2012, 17.5 million deaths were recorded.<sup>1-3</sup> In Latin America, it is the leading cause of death, and it has been found that the mortality of patients with ACS is higher than in

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developed countries.<sup>4</sup> Coronary arteriography is the cornerstone of invasive treatment in patients with acute coronary syndrome.<sup>5-7</sup> This procedure has different techniques to reach vascular access, such as radial, femoral, brachial, and ulnar. Radial and femoral accesses are the most recognized and the ones with the most significant academic support at present.<sup>8</sup>

Femoral access is a procedure that is widely accepted due to its history, operator training, and extensive knowledge in the recognition and management of its complications, the most frequent being: major bleeding,<sup>9,10</sup> localized hematoma,<sup>11</sup> local bleeding, pseudoaneurysm, among others.<sup>11,12</sup> However, in the last decade, radial access has been implemented as the best alternative over femoral access, since a lower incidence of complications has been described with the same clinical results.<sup>13</sup> However, different studies have shown a higher than expected incidence of radial artery obstruction (RAO), and although this has been considered a benign complication, some reports raise doubts about it.<sup>14,15</sup>

Taking into account those as mentioned above, an exhaustive bibliographic review was performed where little information was found describing some vascular complications related to radial access for coronary arteriography, specifically the loss of handgrip strength in the corresponding upper limb of the access, which, if affected, can generate a significant negative impact in patients who have traded, where a subtle use of the upper limb is required, for example, pianists, painters, goldsmiths, artisans, surgeons, etcetera; moreover, in daily activities such as washing, ironing, managing finances, etcetera.

Some studies have suggested no significant compromise of handgrip strength after coronary arteriography with radial access.<sup>14,16</sup> Still, the need for more data is so prevalent that large-scale studies such as ARCUS have already begun to be proposed to answer this question.<sup>17</sup> Also, there are doubts about RAO's benignity and a sub-diagnosis of it,<sup>15,17</sup> and other studies even question whether radial access is better than ulnar in all clinical scenarios.<sup>17</sup> All these reasons make it mandatory to conduct more studies that explore the incidence of complications with the use of radial access after coronary arteriography.

With a particular emphasis on the handgrip strength and its relationship with the radial flow to establish theoretical bases that can help modify protocols and standards currently used for coronary arteriography.

## MATERIAL AND METHODS

It is a prospective observational longitudinal cohort study. We included 77 patients with a diagnosis of ACS confirmed by clinical and laboratory. The patients underwent coronary angiography with a radial access route using the classic Seldinger technique using nitroglycerin bolus diluted in 10 ccs of saline solution.<sup>18</sup> All the patients were treated at the Las Americas Clinic's hemodynamic service between February 2018 and January 2020. We performed a follow-up one month after discharge to evaluate the intervened radial artery's permeability, evaluation of handgrip strength in hand on the same access site, and clinical evaluation of possible complications. To evaluate permeability, we used ultrasound accompanied by the Doppler-color signal made with a 5 MHZ transducer, using General Electric and Toshiba equipment, both equipped with software for interpretation in the field peripheral vascular. Then, an internist with a peripheral vascular subspecialty read the results. We used a comparative hydraulic dynamometer to measure handgrip strength just before and one month after coronary arteriography. We used a Saehan corporation® brand hydraulic dynamometer and handled personnel with prior training and standardization from the American Society of Hand Therapists (ASHT). For this procedure, the patient must be seated with adduction of the shoulder and neutrally rotated, elbow flexed at 90°, the back of the hand and wrist in a neutral position. We made three prehensile force taps, and the average of the results obtained was used for analysis. We obtained Informed consent from all patients.

This research was carried out following international ethical principles for medical research in human beings outlined in the Declaration of Helsinki of the World Medical Association. In the same way, the study was approved by the institutional review board of the hospital.

### Sample

Patients over 18 years of age, diagnosed with ACS, who met the inclusion and exclusion criteria. The sample was taken by convenience.

### Inclusion

Patients diagnosed with ACS with ST-segment elevation by electrocardiography or without ST-segment elevation with an elevation of cardiac enzymes, over 18 years of age, informed consent signature, presence of a radial pulse, and available access defined by the interventionist, patients with availability contact.

### Exclusion

Patients under 18 years of age, with a history of neurodegenerative disease, requiring percutaneous coronary intervention for reasons other than suspicion or diagnosis of the acute coronary syndrome, women with a clinical or laboratory diagnosis of pregnancy, and patients with a history of catheterization due to the same pathway, patients with sequelae of stroke were excluded from the study.

### Data collection

The electronic health records with the questioning of each patient was the source of the following data: socioeconomic, personal history such as hypertension, diabetes mellitus, dyslipidemia, chronic kidney disease (CKD), smoking, stroke (CVA), antiplatelet therapy, and anticoagulation, type of coronary angiography intervention and in-hospital complications.

### Statistical analysis

For the analysis of the data, we used the statistical package IBM SPSS® V.21 licensed from CES University; a p-value less than 0.05 was defined as significant. The population's sociodemographic and clinical characteristics ([Table 1](#)) are represented using descriptive statistics, describing the prevalence of personal medical history in the study population. For bivariate analysis, we performed a comparison of related samples using the t-Student test for

related samples. Also, We carried out a stratified analysis by gender, since the dependent variable defined as an Optimal Force for Instrumental Activities of Daily Living (OFIADL), taken from the disability criteria of the Instrumental Activities of Daily Living (IADL),<sup>19</sup> establishes different reference values between men and women as follows: for women, the optimal grip strength of the hand > 16 kg, and for men > 28.7 kg. Measures below this value: the patients present a functional impairment to daily living activities such as cooking, cleaning, laundry, transportation, and financial management.<sup>19</sup>

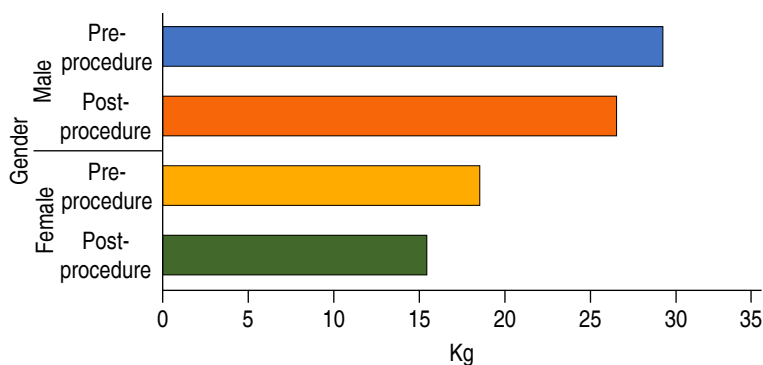
## RESULTS

We included 77 patients, 48.1% women, and 51.9% men; the patients' median age was 66 years (58-72). In total, 14.3% of the patients undergoing coronary arteriography via radial access had a history of cardiac catheterization due to coronary disease performed via femoral access. Other sociodemographic characteristics and background are described in ([Table 1](#)).

For the analysis of handgrip strength, we included all the patients, where a loss of handgrip strength was found in the hand of the access after catheterization. The average of strength before and after the procedure was  $24.16 \pm 7.57$ ,  $21.32 \pm 7.90$ , respectively. We performed the follow-up for handgrip strength at least 30 days after the procedure (95% CI 1.59-4.07,  $p < 0.05$ ).

**Table 1: Sociodemographic and clinical characteristics N = 77.**

Characteristics	Radial access, n (%)
Male	40 (51.9)
Female	37 (48.1)
History	
Hypertension	54 (70.1)
Diabetes mellitus	18 (23.4)
Dyslipidemia	45 (58.4)
Chronic kidney disease	5 (6.5)
Smoking	15 (19.5)
Stroke	2 (2.6)



**Figure 1:** Loss of handgrip strength stratified by gender before the procedure, and after one-month follow-up. Results are expressed as mean  $\pm$  standard error mean.

In the analysis stratified by gender, the mean handgrip strength before catheterization was higher than the optimal value for IADL compared to the post-coronary angiography handgrip strength for both genders (Figure 1).

We defined the radial flow variable as permeable (presence of flow without any alteration) and flow alteration (no arterial flow, non-triphasic flow, intermittent flow). When distributed by gender, female patients had 83.8% arterial permeability after the procedure and men 77.5%.

We constructed the dependent variable optimal handgrip strength for the bivariate analysis considering the IADL criteria that establish cut-points of 16 kg for women and 28.7 kg for men.<sup>19</sup> We compared this variable with the radial flow, personal medical history, and type of intervention. We observed an interesting finding, where having a history of hypertension is the only statistically significant variable related to the loss of handgrip strength after radial access (Table 2).

Regarding vascular complications other than loss of handgrip strength and alteration of arterial flow, we found one patient with perioperative stroke, one patient with unsuccessful angioplasty, and one patient with an immediate complication of arrhythmia (ventricular fibrillation). However, 74% did not report any type of vascular complication ( $p > 0.05$ ).

## DISCUSSION

The most critical finding in the study was the loss of handgrip strength after one month of

follow-up, in patients undergoing coronary arteriography via radial access with ACS diagnosis. This compromise was only related to the procedure's performance since neither the past medical history nor the compromise of vascular flow impacted. The only remarkable variable was hypertension suggesting that it could play a role in optimal handgrip strength. It could be related to the use of arterial vasodilators in hypertensive patients.<sup>18,20</sup> However, studies with higher statistical power are required to confirm this finding. The loss of handgrip strength after an angiography is relevant, given that there is currently limited information, and after a search in databases such as PubMed and Ovid, no publication was found that has studied this phenomenon in the long term, specifically in patients with ACS.

Studies such as ARCUS and HANGAR are the most relevant in measuring the loss of handgrip strength; however, both studies were performed in populations undergoing coronary arteriography, not necessarily with ACS diagnosis, unlike our study.<sup>14,21</sup> An interim ARCUS report, with a sample of 191 patients, showed upper limb dysfunction. However, the methodology used in this study differs from ours since they are based on questionnaire-type scales.<sup>21</sup> On the other hand, when measuring the handgrip strength with a dynamometer, no loss of this was demonstrated, since they used percentages instead of absolute values of the scales proposed by the ASTH. Contrary to what we did in our study, absolute values were used and showed a decrease of handgrip strength in the general population and the same way in the distribution by gender. Additionally, the HANGAR study showed a loss of handgrip strength the day after coronary arteriography. However, in the 30-day follow-up, the handgrip strength returned to its baseline state, unlike our study, where the loss was evident 30 days after the procedure. However, the HANGAR study population was limited only to elective patients with chronic unstable angina.

When analyzing the clinical importance of handgrip strength loss, there was no clear consensus for the objective measurement in the post-procedure setting. Moreover, the scales available for evaluating upper limb dysfunction have little sensitivity and are highly

dependent on subjective standards, making it challenging to apply them in other studies.<sup>21,22</sup> Additionally, even though there are tools such as the hydraulic dynamometer to standardized guidelines for an objective measurement of handgrip strength loss,<sup>22,23</sup> the definitions are inconclusive about a clinically significant loss of strength is. The scales used for strength

classification are not satisfactory for different patients (including category or specification by gender, age, and profession) in the clinical setting after coronary arteriography with radial access.<sup>21,22</sup> After a literature review, we decided to use the disability criteria for IADL,<sup>19</sup> which was initially used to assess handgrip strength loss in patients with sarcopenia. Based on these criteria, we found that the loss of handgrip strength in the analyzed patients translates into a compromise to perform daily living activities in both men and women, representing an essential adverse event since it negatively impacts performance and the fine motor capacity of the upper limb. Thus, leading to an alteration in the performance of specific activities that require this function, such as painting, playing the piano, sculpting, and daily living activities such as cooking, driving, dressing, among others.<sup>24</sup>

Handgrip strength must always be related to different sociodemographic characteristics. Some of these significantly impact their measures, such as age with an indirect relationship, gender differentiation where women have lower values than men, as we demonstrated in the results, which is consistent with other studies,<sup>23,25</sup> and evidences a pattern of behavior that is always maintained.<sup>26</sup>

Although radial flow obstruction has been described as one of the leading vascular complications after coronary arteriography through the radial route with incidences of up to 30%,<sup>26,27</sup> in our study, this was not evidenced as one of the main complications (2.6%) and nor did it show a statistically significant relationship with loss of handgrip strength, which is consistent with important studies such as HANGAR.

Loss of handgrip strength has a significant impact at the systemic level since it is a simple but powerful predictor of future disability, morbidity, and mortality. This was demonstrated in the PURE study, where they found that loss of handgrip strength was related to cardiovascular and non-cardiovascular mortality and the occurrence of cardio-metabolic diseases.<sup>28,29</sup> It is essential to begin identifying which patients may be at increased risk of developing clinically significant loss of handgrip strength following radial coronary arteriography. A consistent

**Table 2: Optimal handgrip strength.**

Variables	Optimal handgrip strength, n (%)		
	Yes	No	p
Gender			
Female	17 (45.9)	20 (54.1)	0.934
Male	18 (45.0)	22 (55.0)	
Cardiac catheterization history			
Yes	3 (27.27)	8 (72.73)	0.191
No	32 (48.48)	34 (51.52)	
Hypertension history			
Yes	19 (35.19)	35 (64.81)	0.006
No	16 (69.57)	7 (30.43)	
Diabetes mellitus history			
Yes	8 (44.44)	10 (55.56)	0.922
No	27 (45.76)	32 (54.24)	
Dyslipidemia history			
Yes	20 (44.44)	25 (55.56)	0.833
No	15 (46.88)	17 (53.13)	
CKD history			
Yes	2 (40.00)	3 (60.00)	0.800
No	33 (45.83)	39 (54.17)	
CAD history			
Yes	4 (33.33)	8 (66.67)	0.359
No	31 (47.69)	34 (52.31)	
Smoking history			
Yes	19 (46.34)	22 (53.66)	0.868
No	16 (44.44)	20 (55.56)	
Type of intervention			
Conventional stent	0 (0)	0 (0)	0.380
Drug eluting stent	15 (50)	15 (50)	
Balloon angioplasty without stent	0 (0)	2 (100)	
None	20 (44.44)	25 (55.56)	
Radial flow permeability (by echography)			
Permeable	26 (41.94)	36 (58.06)	0.207
Flow alteration	9 (60.00)	6 (40.00)	

CKD = chronic kidney disease, CAD = coronary acute disease.



approach might be to try targeting patients with low baseline handgrip strength, patients with neuromuscular diseases, those older than 65 years,<sup>25</sup> and racial groups such as Latinos and Asians could fall into this category.<sup>23</sup>

It is of great importance to recognize this type of complication at an early stage since people with limited mobility and impaired strength can benefit from preventive programs.<sup>27,30</sup> Also, this generates the need to create scales with scores that assess the risks before and after treatment, impact patients' lifestyle, and the performance of their work activities and daily life.

### CONCLUSIONS

For this study, loss of grip strength as a measure of functionality and with an optimal strength cut-off point for IADL, there was a significant loss in both genders, with lower values that can even affect daily living activities. According to the study, loss of grip strength is inherent to the procedure and is not dependent on history or related to post-procedure radial flow. Further studies are required to assess the consequences of this loss of grip strength in patients undergoing coronary arteriography and to assess whether patients who require fine upper limb skills for work activities benefit from other vascular access.

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