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Characterization of the outcome of CT angiography for pulmonary thromboembolism depending on age group and gender

Felix[a] W. F., Veloso[b] M. A. F., Abrantes[c] M. E. S., Miranda[d] R. V.

[a] Unidade de Diagnóstico por Imagem – UDI

Hospital das Clínicas – UFMG - Av. Professor Alfredo Balena, 110.

CEP 30130-100, Belo Horizonte - MG, Brasil

warleyferreirafelix@gmail.com

[b] Universidade Federal de Minas Gerais (UFMG)

Escola de Engenharia - EE

Departamento de Engenharia Nuclear – DEN

Av. Antônio Carlos, 6627 Campus UFMG

CEP: 31.270-901 - Pampulha – Belo Horizonte – MG

[c] Faculdade Ciências Médicas de Minas Gerais (FCMMG)

Pós-Graduação em Higiene Ocupacional/Pós-Graduação em Radioproteção

Alameda Ezequiel Dias, 275

CEP: 30130-110 - Centro - Belo Horizonte – MG

[d] Hospital Erasto Gaertner

Especialização em Dosimetrista para Radioterapia

Rua Dr. Ovande do Amaral, 201.

81520-060 –Curitiba, PR, Brazil

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ABSTRACT

Pulmonary thromboembolism is the third cause of morbimortality between acute cardiovascular diseases and for your diagnosis, Angiotomography is the most used exam in the current. When performing analyzes by gender and age group of the population participating in a study, that they submitted an angiotomography for pulmonary thromboembolism, it was observed that the female gender comprised 65.48% of the population studied with an average age group (55.86 ± 16,88) years and the male 34.52% with an age average of (56.86 ± 16.87) years. Thus, the contrast ratio by age groups between genders was studied, where statistical studies did not show significant differences.

Keywords **TEP, gender, contrast level, age group.**

1. INTRODUCTION

With the advances acquired in image resolution and scanning time by Computerized Tomographs (CT), many diagnostic imaging exams that were considered the gold standard are being replaced by tomographic exams, either because of their cost, accessibility or because they are less invasive in terms of compared to other methods [1, 2].

Angiotomography for the diagnosis of pulmonary thromboembolism (TEP) has replaced, in most cases, angiography of pulmonary vessels and pulmonary ventilation and perfusion scintigraphy, mainly because it is less invasive and cheaper, in addition to having a diagnostic capacity similar to others methods [3,4].

According to Darze et al. [5], between 1989 and 2010, approximately 93,000 deaths caused by thromboembolisms were reported in Brazil. Knowing the Brazilian reality, the study highlights that factors such as inequality in access to health care, the quality of services provided in health care and the difficulties of a clinical diagnosis for TEP that contribute to a possible underestimation of mortality rates due to TEP, a theory reinforced by the low mortality rates from TEP in Brazil compared to the United States [5].

There is an estimate that in the United States, more than 520 thousand cases of TEP occur annually, of which 290 thousand are fatal. There are undiagnosed cases as a result of nonspecific

symptoms, such as chest pain, shortness of breath, tachycardia, among others, which are confused with other pulmonary and cardiac problems [6,7].

Temporarily provoked or reversible risk factors for TEP are surgery, trauma, immobilization, pregnancy, use of oral contraceptives and hormone replacement therapy [2].

When seeking emergency care services, patients with suspected TEP should undergo a clinical investigation, with the application of clinical decision questionnaires that stratify the specific risk for TEP and laboratory tests. With the association of clinical evaluation results, questionnaires and laboratory tests, the decision is made on the need for additional imaging tests to establish the diagnostic [8].

The lack of standardization and optimization criteria in medical exposures, according to Brazil [9], can lead to discrepancies in exam results. In addition, if there are no basic criteria or standardization, it may be impossible to evaluate the test due to lack of contrasting of structures of interest generated by variables such as lack of contrast medium power injector, venous access with smaller caliber than recommended, lower flow rate of injection of contrast medium, puncture site with access different from that recommended, bringing difficulties in making a diagnosis [9].

The analysis of exams in which the contrasting level of the structure of interest is below or beyond the ideal point, provides information with technical-scientific basis so that the procedures and protocols for performing angioTEP (CT Angiography for diagnosis of pulmonary thromboembolism) can be adjusted and optimized in a standardized way. Decreasing the repetition of exams and consequently reducing the radiation doses given to the patient [9].

Since the beginning of CT angiography for the diagnosis of TEP in the institution where the study was carried out, until today, these tests are not performed in a standardized way. Modifications in the form of execution are made according to the experience of the technician performing the examination, or following the guidance of the responsible radiologist.

Variations in the performance of exam techniques basically happen by adapting the tomography protocol, modifying the HU value of the automatic trigger or increasing the contrast medium injection flow rate, or by modifying the location of the medium density reading tool of iodinated contrast in the structure of interest, by decreasing the flow rate of contrast medium injection when the caliber of

the venous access is smaller than recommended or by performing the exam manually due to a shortage of the syringe kit for the contrast medium power injector.

In view of this scenario, this study was designed to assess the population that underwent angioTEP in a public hospital in Belo Horizonte - MG, surveying and characterizing the data that make up the population that underwent angioTEP and evaluated the metrological parameters of this test, to better guide the performance of exams and the technique that presents the best contrasting of the structures to be investigated.

2. MATERIALS AND METHODS

In this context, the different age groups and genders of the population that underwent PTCA in a public hospital in Belo Horizonte were analyzed, with a total of 504 participants with 330 female participants and 174 male participants, in order to know the profiles of this population. This study was approved both by the Research Ethics Committee/UFMG and by the Teaching and Research Management of the hospital under the number CAAE – 86446218.4.1001.5149.

2.1 The exam for angioTEP and your technical characteristics

The exam for angioTEP is a scan of the patient's chest using a computerized tomography, simultaneously with the automated injection of iodinated drug in order to contrast the pulmonary artery and its branches, showing or not the presence of thrombi that obstruct the blood circulation in the lung.

To perform the angioTEP exams, a 64-channel Toshiba® tomograph and two contrast medium injectors from the manufacturer Medrad® were used, with the same characteristics of execution of the contrast medium injection protocol.

The parameters raised and pre-fixed in the Institution's routine protocols for angioTEP exams are: Execution of the exam in the caudocranial direction, covering the entire lung area, with automatic triggering (surestart[1]) programmed to start the angioTEP when the density in the structure of interest

[1] CT Density Reading Tool in HU (Toshiba®) is responsible for the automatic start of the exam when reaching the programmed density reading [11].

to reach 80 Hounsfield Unit (HU), and the peak voltage of 120 kV, with modulated electric current intensity, and the X-ray tube rotation time of 0.5 second, with the relation between table displacement, X-ray tube rotation and 0.828 slice thickness (spiral pitch) and no apnea command.

2.2 Methods of performing the angioTEP exam

The angioTEP protocol was initially configured with automatic triggering when reaching a density of 90 HU in the pulmonary artery trunk, and the injector manufacturer's recommendations are for the use of a venous access through a plastic cannula device of at least 18 gauges caliber, Bae [10], and 3.5 ml/s venous contrast medium injection flow rate. With this initial configuration, the exams were performed and it was observed that they presented low contrast in the structure of interest. With this in mind, attempts were made to modify the protocol, mainly in relation to the contrast medium injection flow rate and the automatic triggering of the exam, in an attempt to improve the contrasting level of the structure of interest. Needing a study based on bibliographic reviews of CT angiography and AngioTEP by the medical staff. The changes made were injection flow rate values and automatic start of the exam. Because of this, the best response configuration was found and used as the current protocol with automatic start of the exam with reading at 80 HU and contrast medium injection flow rate of 4.5 ml/s [10].

2.3 Image analysis program

The Horos Software was used to analyze the tomographic images, obtaining the average contrast values of the structures of interest, generating density reading tools, creating illustrative images. Horos is an open source software, and its main purposes are the visualization of medical images, 3D rendering, multiplanar reconstructions and curves. One of its main restrictions is the lack of licensing by the Food and Drug Administration (FDA) for use in medical diagnosis, however it is widely used in the medical field as a diagnostic aid. The Software is licensed under the GNU Lesser General Public License, which is approved by the Free Software Foundation [12].

2.4 The contrast médium and the contrast level

The tomography department at this institution uses non-ionic iodinated contrast medium in 50 ml vials with an iodine concentration of 300 mg/ml.

According to the article by Halpern [13], the contrasting level of the structure of interest for angioTEP must be between 300 to 350 HU so that the radiologist responsible for the report can confirm or refute the presence of PET. Another recommendation is the use of a contrast medium with an iodine concentration of 350 mg/ml or higher [13, 14, 15].

2.5 Image analysis

Analyzes of tomographic images were performed by selecting the image that best visualizes the pulmonary artery trunk and bifurcation. A density reading tool at ROI (region of interest) was used, with an elliptical shape with an area of 1.00 cm2, and these ROI were positioned one close to the pulmonary artery bifurcation and the other in the thoracic aorta to define their mean levels of contrast, in HU, and determine the contrast ratio (R_ZC) between these structures by dividing the mean value found in the pulmonary artery by the mean value found in the thoracic aorta, from which it was observed that the higher the R_ZC value, the greater the contrast in the pulmonary artery.

Based on the contrasting level suggested by Halpern [13], the structures of interest in angioTEP can be considered as early, where the contrasting is insufficient for the diagnosis (figure 1), ideal, where the contrasting in the structure to be studied is well visualized without overlapping other structures with close contrast level (figure 2) and late, where the contrast reached structures that overlap the structures of interest, making diagnosis difficult (figure 3) [13].

Figure 1. AngioTEP early. Structure of interest with low contrast (arrow).

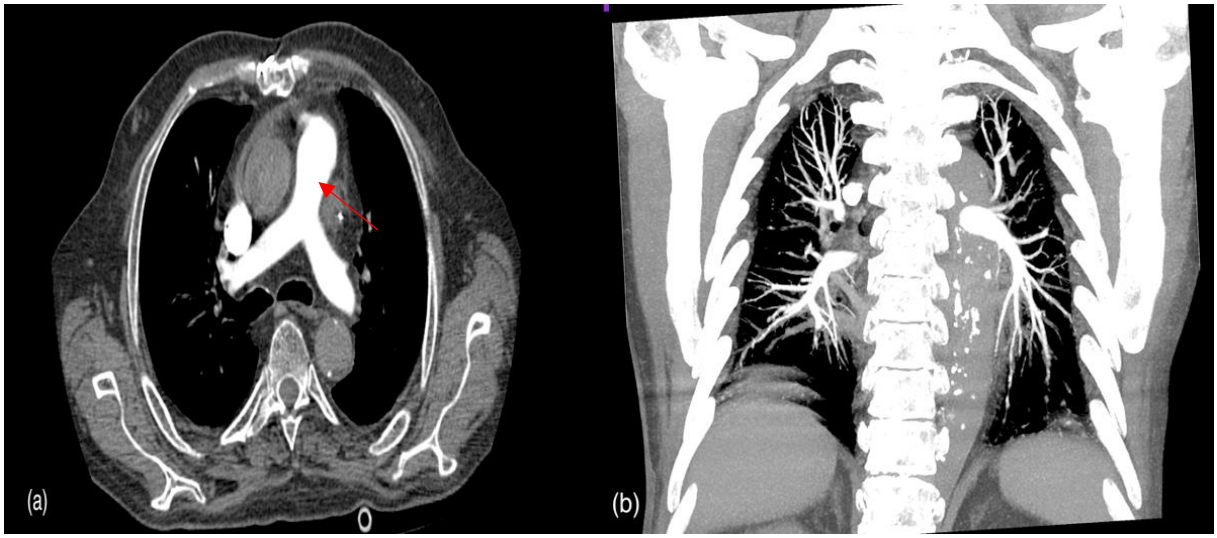

Figure 2. *AngioTEP ideal*
a) Structure of interest with ideal contrast (arrow); b) reformat into maximum intensity projection (MIP).

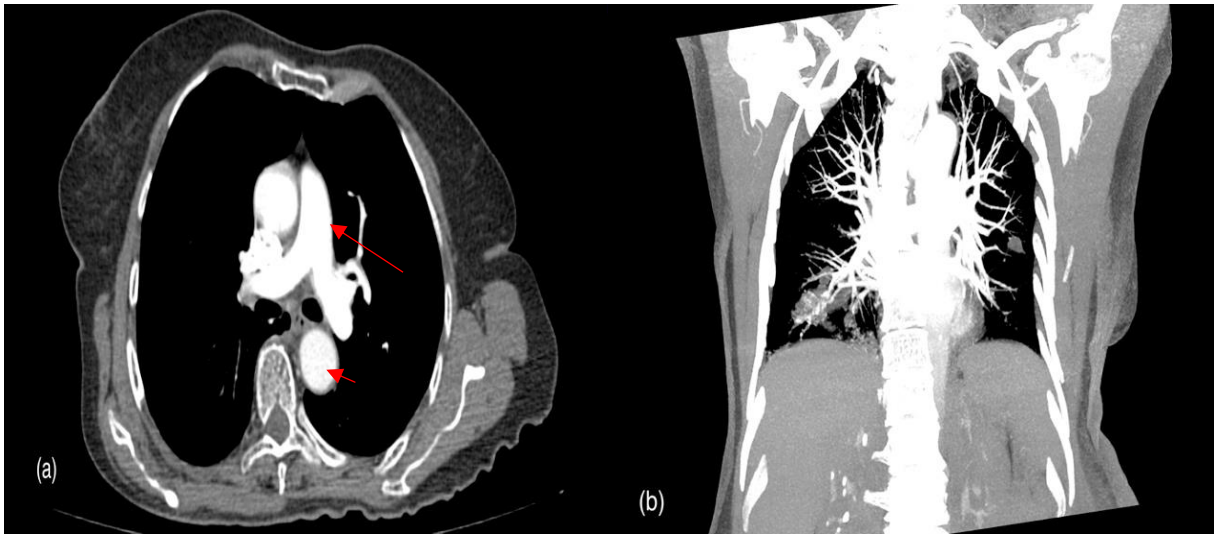

Figure 3. *AngioTEP tardia*

a) a) Structure of interest with ideal contrast (long arrow) and high contrast of struture not of interest (short arrow); b) reformat into maximum intensity projection (MIP).

3. RESULTS ANDE DISCUSSION

It appears that females represent 65.48% of the studied population with a mean age of 55.86±16.88 years and males represent 34.52% with a mean age of 56.86±16.87 years. The largest number of participants being from the female group can be explained by Konstantinides et al. [2], where in their study it is shown that almost 50% of the risk factors temporarily provoked or reversible is associated with the female gender, increasing the incidence of cases in this group [2].

Variations in the technique of performing AngioTEP produce a variety of mean contrasting results in the structure of interest, and in Figures 4 and 5, the distribution of these variations by age group for each gender is observed.

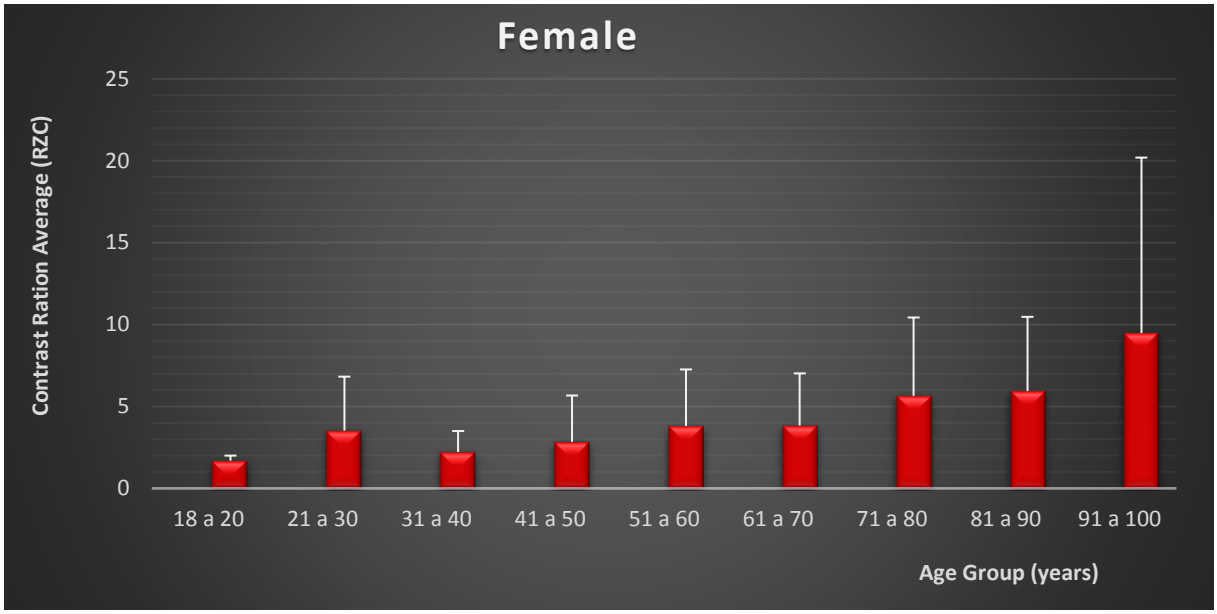

Figure 4. Contrast Ratio Average and for age group and gender female

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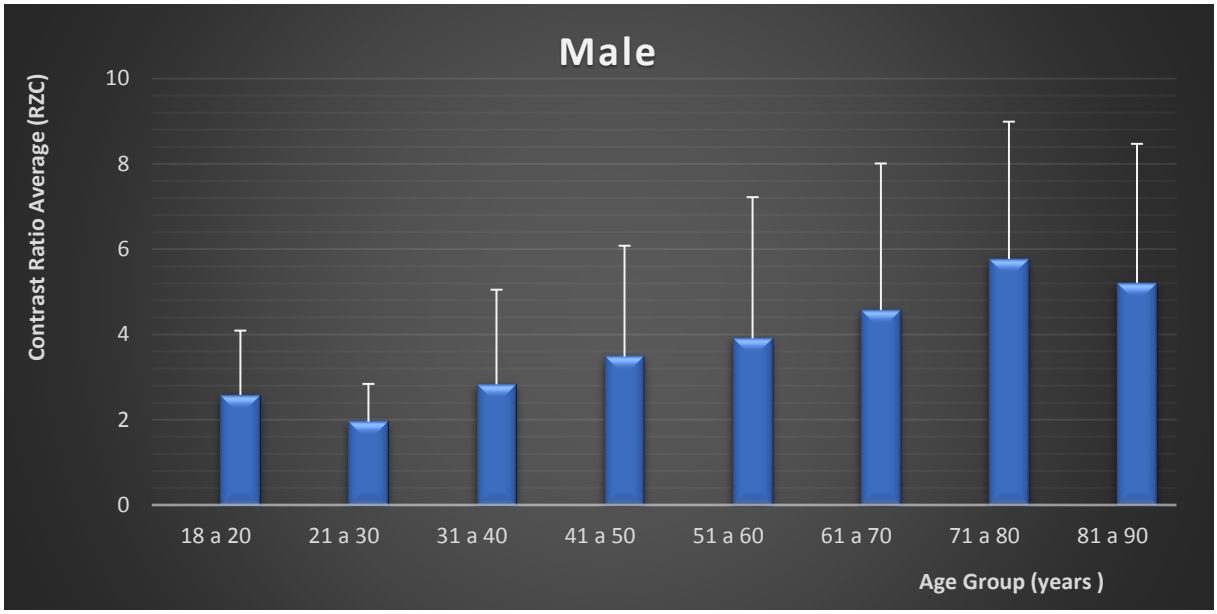

Figure 5. Contrast Ratio Average and for age group and gender male

According to the results of the contrast ratio by gender and age group obtained, it was verified that the age group of the female group that presented the highest R_ZC was 91 to 100 years old

(9.48±10.71) and for the male group the age group with the highest R_ZC was 71 to 80 years old (5.77±3.22).

It is observed that for females and males, the increase in age group is accompanied by an increase in the contrast ratio, except in the male group and in the age group from 81 to 90 years, when there is a reduction in R_ZC compared to the previous age group.

Statistical analyzes were performed using the bilateral Student's t test, according to table 1, to assess the statistical significance in the comparison between genders and age groups. The level of statistical significance of 5% (0.05) was adopted, through the analysis of the p-value < 0.05 as an indication of the existence of a statistically significant difference between the mean values of the studied groups and p-value > 0. 05 indicating the non-existence of statistically significant differences [16].

The inexistence of statistically significant differences does not imply that these differences have no clinical relevance Hulley et al [16], and no statistically significant difference was found by the method [16] in the studied groups.

Table 1. Comparative *Student's* test t results between genders and age groups**.**

Age Group (anos)	Test T (p)
18 a 20	0.458
21 a 30	0.092
31 a 40	0.709
41 a 50	0.227
51 a 60	0.165
61 a 70	0.071
71 a 80	0.110
81 a 90	0.705
91 a 100	-

In the age group from 91 to 100 years, the statistical study was not carried out because they only had members in the female group

4. CONCLUSIONS

It was observed that the population studied is mostly female, with approximately twice the number of members of the male group, in agreement with Konstantinides, et al [2], who establish in their study the factors temporarily provoked and/or reversible for thromboembolism and the greater susceptibility of the female group to the occurrence of pulmonary thromboembolism [2]

In the graphs presented in this work, it is observed that, with increasing age, there was also an increase in the R_ZC, which may indicate that with population aging there may be a decrease in metabolic activity and a consequent reduction in cardiac output and other comorbidities that can explain this behavior.

The diversity in the contrasting levels of the structures of interest may occur due to the lack of standardization of AngioTEP, which may cause possible repetitions of exams or carry out other imaging exams that use ionizing radiation to establish the diagnosis. Therefore, the standardization of processes and protocols for performing angioTEP maximizes the optimization of exams and minimizes the repetition of exams, thus, reducing the doses of ionizing radiation to which patients are submitted.

With the R_ZC results involving patient genders and age groups, this study does not present statistically significant differences in Student's t tests, which does not mean that these differences have no clinical relevance.

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