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Pre-Operative Evaluation of the Internal Thoracic Artery from the Morphology of Thorax and Morphotypia: Preliminary Study

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Abstract		Original Research Article

The internal thoracic artery (ITA) is the graft of choice in coronary bypass surgery, despite insufficient means for its pre-operative evaluation. Therefore, we propose an alternative based on statistical correlation. From 23 anatomical adults fresh subjects, we evaluated the morphotypia and measured diameters and length of the ITA. The correlations show a relationship between the morphotypia and the length of the ITA and that between the circumference of the thorax and the diameter of the ITA. Therefore, the clinical exam will provide an idea of the ITA's quality using a mathematical formula.

Keywords: ITA, chest circumference, ITA length, morphotypia, ITA diameter.

INTRODUCTION

As part of the preoperative assessment of coronary artery bypass surgery, a step is devoted to the study of the quality of the graft. The exploration of the internal thoracic artery was preferably done by angiography, after catheterization of the artery. This exploration made it possible to have a complete cartography thus showing possible anatomical variations and pathologies [1, 2].

Doppler ultrasound remained the choice for flow measurement, both before and after bypass of the ITA on a coronary artery [3-6]. It was also recommended, for the morphological study, in the event of contraindication to an angiography [7].

We propose an appreciation of the length and the diameter of the ITA from a correlation with fixed marks of the thoracic wall.

MATERIAL AND METHODS

To carry out this work, we had dissected 46 internal thoracic arteries including 23 right and 23 left on 23 fresh adult anatomical subjects composed of 3 women and 20 men presenting no traumatism or thoracic deformation.

This study was carried out simultaneously at the pathological anatomy departments of the Aristide Le Dantec (HALD) and General de Grand Yoff (HOGGY) hospitals.

To carry out this work, we used:
- a common dissection box with a costotome;
- a tape measure;
- a compass;
- a digital camera;
- a computer;
- Epi-Info software version 3.3.2, for statistical analyzes.

On the subject, installed in supine position, we noted the morphotypy and measured the circumference of the thorax at the height of the middle of the line connecting the acromion to the lateral epicondyle of the humerus as well as the height of the thorax at the mid-level clavicular.

The morphotype was defined relative to the angle formed by the two cost edges. If this angle is greater than 30 °, the subject was said to be Brevilic and if this angle is less than 30 °, it was said to be Longilic.

The approach was a mid-thoracic-abdominal incision from the sternal jugular notch to the pubis. The anterior musculo-cutaneous wall of the thorax was completely detached from the rib grill to the left and right middle rib arches. The rectus abdominis muscles were cut transversely in addition to the umbilical, to facilitate the recline of the musculo-cutaneous wall of the thorax and thus improve the exposure of the sterno-costal bib.

The ribs were sectioned at the level of the anterior arches from K1 to K7 and a sternoclavicular disarticulation was performed on both sides.

The breastbone was also separated from the pleura, pericardium and other elements of the mediastinum, while avoiding damage to the internal thoracic arteries.

After section of its attachments, the sterno-costal bib was lifted from bottom to top which allowed to visualize its posterior face.

The ITA were visualized after separation of the latter with the cellulo-fatty tissue of the posterior surface of the sterno-costal bib and section of the transverse muscles of the right and left sternum.

After opening of the vascular sheath and separation from the internal thoracic veins; the dissection of the ITA was done, starting at the level of the sternal manubrium, by a gentle traction. This dissection was continued, distally, by the section and the reclinement of the transverse muscle of the sternum. Thus, still by gentle traction, the ITA was separated from its satellite veins until it branched off.

This dissection allowed us to note:
- the total length of the ITA;
- the external diameter of the original ITA;
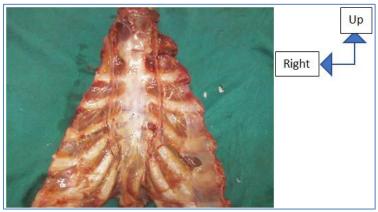- the external diameter of the ITA at costal levels from K1 to K6.

Fig-1: Plastron sterno-costal: fascia endothoracique disséqué

RESULTS
Morphotypia
The brief morphotype was found in 16 subjects and the long one in 07 subjects; which corresponded to respective percentages of 69.6% and 30.4%.

Measurements of the thorax
The average chest circumference was 71 cm while the minimum was 44 cm and the maximum 92 cm.

ITA length
The average total length of the ITA was 171.7 and 172.4 mm respectively on the right and on the left. The extreme lengths were 120 and 260 mm, on both sides. The most common lengths were 150 mm on the right and 145 mm on the left.

In 04 cases the exact length of the artery could not be determined, due to its continuity with the lower epigastric artery.

ATI diameters
Origin
The diameters at the origin of the right and left internal thoracic arteries were on average 3.1 mm with a smaller diameter at 2 mm and a larger diameter at 5 mm. The most frequently encountered diameter was 3mm.

At the trunk level
At the right rib levels, from K1 to K6, the average diameters varied between 2.6 and 3.05 mm while on the left, they were between 2.6 and 2.9 mm. The most frequent diameter was 3mm (Tables I and II).

Table-I: Variations in diameter of the right ITA according to costal levels from K1 to K6

Costal levels	Mean Diameters (mm)	Minimal diameters (mm)	Maximal diameters (mm)
K1	3,05	2	5
K2	3,05	2	5
K3	3,01	2	5
K4	2,96	2	5
K5	2,79	1	4
K6	2,65	1	4

Table-II: Variations in diameter of the right ITA according to costal levels from K1 to K6

Costal levels	Mean diameters (mm)	Minimal diameters (mm)	Maximal diameters (mm)
K1	2,87	0,3	5
K2	2,99	2	5
K3	2,96	2	5
K4	2,92	2	5
K5	2,72	1	4
K6	2,66	1	4

Correlation and comparison (table III)

We compared and correlated, by statistical tests, the average length and diameter of the ITA with other parameters.

The average length of the ITA
According to the morphotype

A simple bilateral Student test is performed with a significance level of 5%. Crosses between the morphotype and the average lengths of the right and left ITA showed a p value of 0.03005 and 0.01717 respectively. This result means that the lengths of the right and left ITA are longer, in longilic, with a statistically significant difference.

According to the circumference of the thorax

A Pearson linear correlation, between the circumference of the thorax and the total lengths of the right and left ITA, is made. The p values are less than 5% and the absolute values of the correlation coefficients are less than 1. These results show that there is no link and no correlation between the circumference of the thorax and the total length of the ITA.

Depending on the height of the chest

Pearson's linear correlation test shows that there is no link and correlation between the height of the chest and the total length of the ITA.

According to the height of the sternum

According to the Pearson test, the p value is less than 5% and the correlation coefficient is close to 1. Thus there is a link and a correlation between the height of the sternum and the total length of the ITA; but it's not linear.

Between the circumference of the thorax and the diameter of the ITA

This correlation with the same Pearson test gives as a result a p value of 0.00695 and a correlation coefficient of 0.5466808. This result means that there is a link and a correlation between the circumference of the thorax and the diameter of the ITA.

Table-III: Correlation and link between some quantitative variables

correlation	P value	Correlation coefficient	Interpretation
Chest circumference and total length of right ITA	0 ,368	-0 ,1968542	- No link - No correlation
Chest circumference and total length of the left ITA	0,59	-0,1185709	- No link - No correlation
Chest height and right ITA length	0,09586	-0,3556043	- No link - No correlation
Height of chest and length of left ITA	0,09178	-0,3597541	- No link - No correlation
Height of sternum and total length of right ITA	0,1356	0,320775	-Existence of a link -Existence of correlation
Height of the sternum and total length of the left ITA	0,02465	0,4670292	-Existence of a link -Existence of correlation
Chest circumference and right ITA diameter	0,0505	0 ,4124344	-Existence of a link -Existence of correlation
Chest circumference and left ITA diameter	0,00695	0,5466808	-Existence of a link -Existence of correlation

DISCUSSION

Knowledge of the course and quality of the internal thoracic artery has always preoccupied cardiac surgeons since the discovery of the efficiency of this artery as a graft in coronary bypass surgery. This internal thoracic artery has several qualities in comparison to other arterial and venous grafts. The ITA is the only peripheral artery in the human body that is elastic, being composed of an intima that is lim- ited by a well-formed internal elastic lamina and a media that is formed by a network of circularly and longitudinally interlacing elastic lamellae between which smooth muscle cells are dispersed in a spiral fashion [8].

The endothelium of the ITA is itself unique with a sig- nificantly higher basal production of vasodilators such as nitric oxide and prostacyclin. The ITA demonstrates a favorable response to the pharmacological agents commonly used in the postoperative period [9, 10]. Although the difference in endothelial-derived relaxation factors among the arterial conduits (ITA, radial, and inferior epigastric arteries) is less, the difference between the ITA and saphenous vein is marked [11]. The ITA dilates in response to milrinone and nitrogly- cerine [12, 13]. It does not constrict in response to nor- adrenaline [12, 13]. The endogenous secretion of vasodilators may also have a downstream effect on the coronary vasculature, explaining the common observation that the coronary target itself appears relatively protected distal to the anastomosis. The important cause of ITA spasm is thromboxane secretion due to injury during ITA harvest and preparation of the graft [14]. Papaverine, a short-acting phospho-diesterase inhibitor, is a widely used vasodilator to treat vasospasm of the ITA. The ITA pedicle is sprayed with papaverine solution or wrapped in papaverine- soaked gauze. The intraluminal injection of papaverine may cause endothelial injury [15, 16].

Despite these many advantages, the fear of the cardiac surgeon is to locate the internal thoracic artery but also to have a good caliber artery with a correct length in order to allow correct anastomoses. Indeed, the only means of 100% sensitive exploration allowing to have an idea of the caliber and the course of this artery is angiography. The latter is expensive and invasive. This is how Lee[17] provided a precise landmark with which to locate the internal mammary vessels, using the "1-2-3 rule." Lee *et al*. found that the vessels were located medially to the costochondral junctions at 12.80, 24.78, and 33.28 mm at costal levels 2, 3, and 4, respectively [17]. The authors' proposed 1-2-3 rule easily depicts the mean distances between the costochondral junctions and internal mammary arteries to be 1, 2, and 3 cm, with a deviation of 5 mm at costal levels 2, 3, and 4 [17].

On the other hand, demonstrates that this rule does not apply to longilic subjects. Note that Lee carried out his study on an Asian population, therefore small.

Our work is part of this same remote appreciation register of the thoracic artery. Indeed, our correlations between the diameter of the internal thoracic artery and the largest circumference of the thorax, on one side, and the morphology and length of the artery, on the other hand, will allow us to evolve towards formulas to calculate the length and diameter of the ITA.

CONCLUSION

ITA has generated a lot of interest in bypass surgery. The only current constraint remains its pre-operative evaluation which remains almost impossible. Our correlations constitute a springboard to evolve towards a calculation of the length and the gauge in pre-operation.

Authorization of the ethics comittee

The Ethics Committee of the Faculty of Medicine and Odontotology of Dakar gave us its agreement for the realization of this study.

CONFLICTS OF INTEREST

The authors of this article declare that there is no conflict of interests.

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