

Experience with a method for anatomic dissection that allows macro and microscopic examination of the cardiac arteries

Experiência com um método para dissecação anatômica que permite o exame macro e microscópico das artérias cardíacas

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ABSTRACT

Aims: There are few descriptions of techniques for dissecting the cardiac arteries. This article presents the experience with a technique that allows histological evaluation of atherosclerosis and concomitant macroscopic evaluation of anatomic alterations.

Methods: Fifty dissections were performed by using this technique. The arteries from the inferior wall are dissected first, from their ends until their origins, then the anterior wall, the left coronary and the right coronary arteries.

Results: Dissection takes from 20 to 40 minutes to be performed. All anatomic alterations could be evaluated, and there was no compromising in the analysis of atherosclerosis. The heart and the adipose tissue could be used afterwards for further analysis.

Conclusions: This technique is specific for the dissection of the arterial bed of the heart for the analysis of atherosclerosis possible anatomic alterations. Damage to the vessels and the myocardium is minimum, and the technique is fast and can be easily performed during autopsies or adapted for the surgical center.

KEY WORDS: AUTOPSY; ANATOMY; DISSECTION; HEART/anatomy & histology; CORONARY ARTERIES.

RESUMO

Objetivos: Há poucas técnicas descritas para a dissecação das artérias cardíacas. Este artigo apresenta a experiência com uma técnica que permite a avaliação histológica da aterosclerose e análise concomitante de alterações anatômicas.

Métodos: Cinquenta dissecações foram realizadas através desta técnica. As artérias da parede inferior são dissecadas primeiro, do seu fim até sua origem, depois a parede anterior, a artéria coronária esquerda e a direita.

Resultados: A dissecação demora entre 20 e 40 minutos para ser realizada. Todas as alterações anatômicas puderam ser avaliadas, e não houve comprometimento da análise de aterosclerose. O coração e o tecido adiposo puderam ser usados posteriormente para outras análises.

Conclusões: Esta técnica é específica para dissecação do leito arterial cardíaco visando análise de aterosclerose e possíveis alterações anatômicas. A lesão aos vasos e ao miocárdio é mínima, a técnica é rápida e pode ser facilmente realizada durante autopsias ou adaptada para o centro cirúrgico.

DESCRIPTORIOS: AUTOPSIA; ANATOMIA; DISSECAÇÃO; CORAÇÃO/anatomia & histologia; ARTÉRIAS CORONÁRIAS.

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INTRODUCTION

Quidne mortui vivos docent? What do the dead teach the living? Commonly performed by the Egyptians and Greeks in the Ancient Era, regarded as profane in the Middle Age, reborn in the Renaissance and reintroduced in the medical curriculum in the XIX Century, anatomic dissection has been the base of medical teaching for at least one hundred years.¹ In the late XX Century and beginning of the XXI, though, anatomic dissection is becoming obsolete, as internal organs can be accessed through imaging techniques from X-rays to magnetic resonances. In spite of that, there are certain analyses and researches that can only be performed through dissection.

Textbooks and articles describe techniques for dissecting the heart, however there is little importance as to how to dissect the coronary arteries and its branches.^{2,3} The most common technique is “breadloafing”: performing sequential cuts of 5 mm along the track of the coronary arteries from their end to their origin.^{4,5} Such technique, though sufficient for identifying atherosclerosis, not only is of little worth when examining the anatomy of the cardiac arteries, but also hinders the process.⁵

When performing the anatomic dissections for the AMA Study (Multi-Arterial Atherosclerosis),⁶ we had to obtain the cardiac arteries with as little damaging and manipulation as possible, as it might compromise the evaluation of atherosclerosis,⁷ and so that other analyses could also be performed. Having found no technique described for this requirement, but mostly techniques that could be inferred from medical articles and had both advantages and disadvantages, we developed our own.

METHODS

This study was approved by the Ethics in Research Committee from Centro de Ciências Médicas de Sorocaba, in June, 2010.

Minimal material and requirements of the technique

Spencer scissor (9 cm); rat-tooth forceps (10 cm); straight Kelly forceps (14 cm); curve Kelly forceps (14 cm); scalpel number 04, blade number 23. Magnifying glass is not necessary, however it can be used.

In order to be adequate, the technique had to cause as little damage as possible (or none at all) to the arteries and the heart. Every connection between the

arteries should be available for macroscopic analysis, the atherosclerotic plaques could not be broken or dislodged, and the arteries could not be cut or separated before the complete dissection. It should also be as little time-consuming as possible, and equally applicable for fresh or conserved hearts.

Description of the technique

Dissection begins after a thorough evaluation of the whole heart and identification of ventricles, atria, coronary arteries, their branches, and any possible anatomic variation, anomaly or malformation (Figures 1-1 and 1-2). The posterior wall is dissected first, from the heart’s apex to its base. When the heart has more adipose tissue surrounding the arteries, the scalpel may be used to cut the fat around the artery and allow an easier dissection with the scissor. However, when the heart has few or no adipose tissue, it is safer to use the scissor in order to cut a few millimeters through the myocardium as a tunnel underneath the artery.

Fat is easily differentiated from myocardium by tactile sensation, by using either the scalpel or the scissor. Fat offers the least resistance, then veins offer a little more, arteries offer a moderate resistance, and even a strong resistance if there are calcified plaques, and the muscle offers a definitely strong resistance. A delicate incision, even without direct sight, allows a quick identification of the tissue being dissected after some experience.

Cutting the side margins makes the mobilization of the artery easier. Once the sides are dissected, the artery resection begins by its end (Figure 1-3), first the posterior descending artery (PDA), then the circumflex artery (Cx), and finally the marginal artery. The adipose tissue is cut in a V form a few millimeters distal to the artery, and this segment will be held by the forceps and used as support. The adipose tissue (or the myocardium) is lifted by using the forceps, and the tissue underneath it is dissected. The perforating vessels may be either transversely cut or dissected for further analysis.

The forceps can be held horizontally, gently supporting the further end. As the adipose tissue is considerably friable and the vessel has a very small diameter at this point, once at least one centimeter of the arterial bed has been dissected, a more proximal segment can be used for support. There is little chance of damaging the vase at this point. Also, a small layer of myocardium may be dissected as well for a better support (Figure 1-4). It may also be easier using the fingers for holding the vessels, instead of forceps.

Dissection proceeds upstream towards the heart base until the atrioventricular sulcus, where the coronaries lay. Before starting on these arteries, it is recommended to proceed to the Cx and the right marginal arteries, by using the same technique (Figure 1-5).

The resection of the right marginal artery will be performed at two steps; first, the posterior part. The heart lays on its anterior wall, and by using the scalpel the initial incision is made on the adipose tissue. Next, the scissor is used for carefully penetrating towards the myocardium which will be used as a base for avoiding any damage to the artery (Figure 1-6). Dissection must be careful, as this area of the heart has a natural edge.

After that, the coronary arteries will be dissected. A first incision is to be made on the adipose tissue above the arteries, superior and lateral to the PDA, between

it and the right marginal. Then, by using the scissor, the adipose tissue is separated from the myocardium (Figure 1-7). By using this lateral approach, the coronary venous sinus that lies between the PDA and the Cx will be avoided. It is a site that has less vessels and the right coronary artery (RCA) is relatively isolated in the adipose tissue. Next, an inferior incision is made, in order to isolate the adipose tissue and the arteries from the myocardium (Figure 1-8).

The resection is expanded towards the marginal artery and the posterior interventricular artery (PIA), dissecting it completely, whereas not separating it from the RCA. The PDA may be pulled upwards, allowing a better view of the dissection field. At this point, the closed scissor is of great use in presenting the tissue without damaging it.

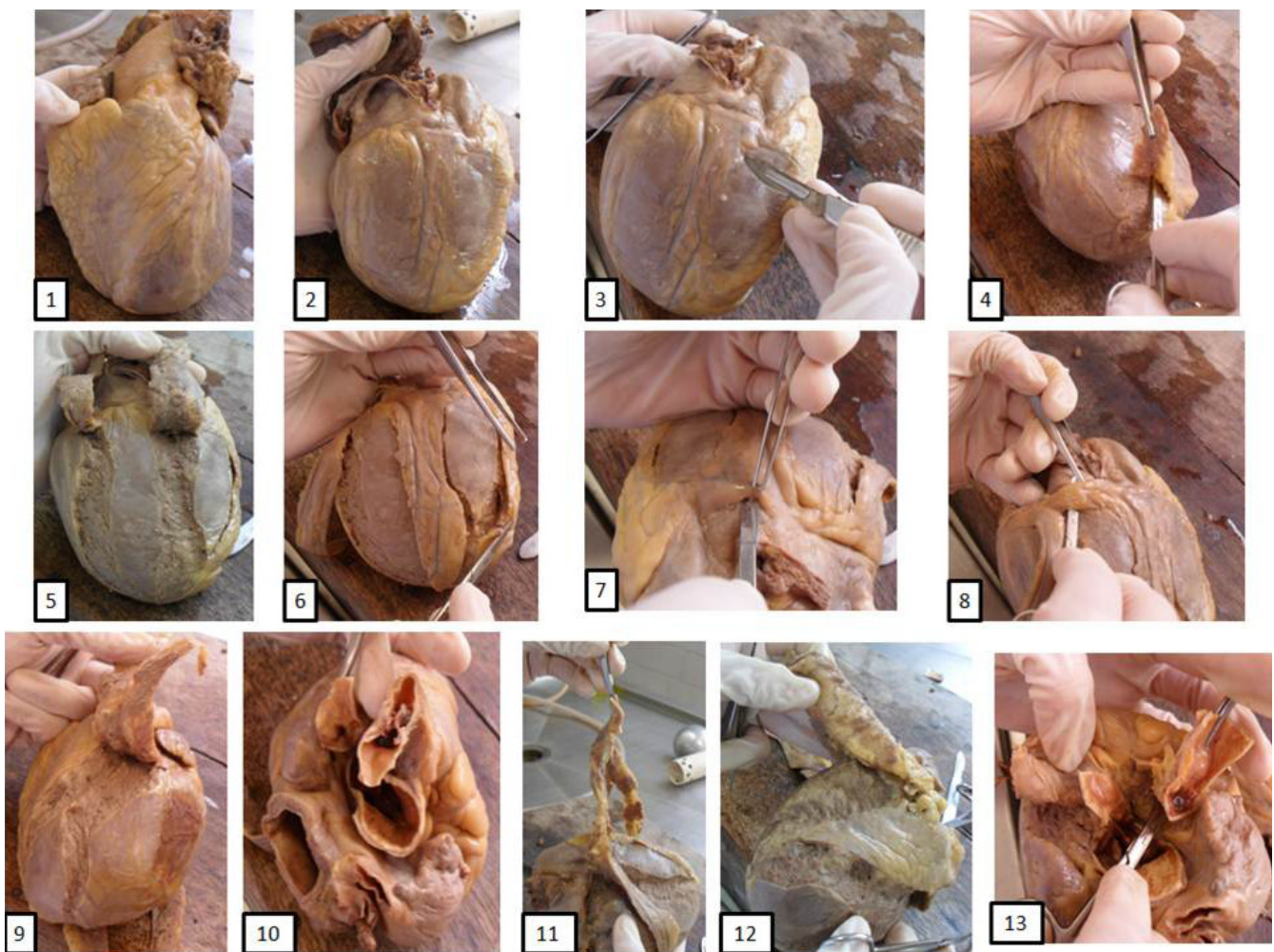


Figure 1. A heart for dissection. **1:** Anterior wall. **2:** Posterior wall. **3:** Beginning the dissection of the posterior interventricular artery (PIA). **4:** Detaching and pulling up the PIA. **5:** Pulling up the PIA and the circumflex artery (Cx). **6:** Dissecting the posterior part of the right marginal artery. **7:** Beginning the dissection of the right coronary artery (RCA). **8:** Dissection through the inferior part of the RCA. **9:** Anterior interventricular artery (AIA) pulled up. **10:** Opening the aorta near the ostium of the left coronary artery (LCA). **11:** LCA and RCA dissected up until the right marginal artery. **12:** Dissection of the anterior part of the right marginal artery. **13:** Dissection of the aorta for the ostium of the RCA.

Dissection then proceeds until the anterior descending artery (ADA). Differentiating the left coronary artery (LCA) from the adipose tissue, the coronary sinus and the left atrium may be quite hard. However, once the LCA is located, the adipose tissue can be cut throughout whereas avoiding the coronary sinus. If it is too hard to identify the artery, the scissor may be used to perform tangential cuts in the fat so as to expose it.

The dissection of the LCA from the Cx until the ADA must proceed carefully, as the heart has another natural edge at this site, the LCA goes deeper into the adipose tissue, and there may also be muscular bridging, being it hard to separate it from the myocardium. In such case, the segments where the artery penetrates and then emerges are to be found, and the myocardium should be cut around the artery with the scissor, detaching it from the muscle. Also, the auricula may compromise the direct observation of the artery; in such case, it may be held off by using the curved Kelly forceps. If the curve is too sharp or there are too many muscular bridges, the LCA may be later dissected downstream from its origin.

Once the LCA is dissected until its trunk or the origin of the ADA (or left for later), the same resection technique is used to dissect the AIA from its end upwards (Figure 1-9). The nearer the left main trunk, the higher the chance of the artery penetrating in the myocardium.

Once the resection has reached the left main trunk, it may be rigid due to calcification and its mobilization may break its plaques. At this point, it will be left for a later downstream dissection from the origin of the

LCA in the aorta. The aorta is separated from the pulmonary artery as much as possible, what makes it easier to identify the LCA. The ostium of the LCA is identified, generally in the left semilunar valve. By moving the closed scissor on the artery's wall, the ostium can be identified even without direct sight. The aorta is then cut around the ostium, as near as possible without damaging it, and the already dissected part is presented with one of the Kelly forceps, what allows a better visualization of the ostium and prevents it from cutting through the LCA (Figure 1-10). As the aorta has been dissected, the coronary presents little resistance to detachment; it shall be dissected from underneath and downstream by using the scissor (Figure 1-11).

Once the left main trunk (and the rest of the LCA that hadn't been dissected) has been dissected the other arteries will be easily detached, just like a crown. It is then recommended to finish dissecting the right marginal artery on the anterior wall, exactly like it was dissected on the posterior wall (Figure 1-12). After its complete resection, the RCA is dissected by using the same technique that is described for the LCA (Figure 1-13).

The RCA ostium lies on the right aortic valve sinus. The site the RCA emerges from usually presents more adipose tissue, is in general very close to the emergence of the right marginal artery, and is occasionally obstructed by the right auricula. When the origin of the right marginal artery is finally dissected, the whole arterial bed will be easily detached (Figure 2). From this on, the vessels can be cautiously separated from the surrounding adipose tissue, either by using a small scissor or a scalpel.



Figure 2. Dissected heart and exposed arterial bed. Observe the resemblance of a dry riverbed on the heart's surface. From the left to the right: left coronary artery, anterior interventricular artery, circumflex artery, posterior interventricular artery, right marginal artery and right coronary artery.

RESULTS

From August, 2010, to June, 2011, 50 hearts were dissected by using this technique. As the pathologist gains experience with the technique, it takes less than 40 minutes to dissect the whole arterial bed. If the arteries are quite evident and the tissue is not too fixed by formaldehyde, it takes around 20 to 30 minutes.

Macroscopic analysis

This technique has allowed evaluating all the arterial origins, anastomosis, anatomic variations and malformations in the 50 dissected hearts. In the only case in which the connection between the Cx, the PIA and the coronaries could not be identified, the patient had Chagas' disease and the macroscopic appearance of the arteries was similar to that of veins. In this case, despite following the coronary arteries from their origins until their ends, the connections could not be evidenced.

By using this technique, after the dissection the arteries can be opened either longitudinally or transversely (bread-loafing) for analysis without difficulties. Also, the posterior exterior part of the vessels can be analyzed.

Histological analysis

In all the 900 sections performed in this study for histological analysis, none was compromised by this technique. Sometimes the arteries could not be differentiated from veins, due to their diameter (<2 mm), but fixating the whole block dissected was a trustful solution. Also, some sections were compromised due to calcifications, as the artery would break once it was cut in the microtome.

Difficulties and failures

Most difficulties were found when dissecting the coronaries from their ostiums until their first branches; in such locations, there is eventually too much adipose tissue and the arteries must be dissected without direct view. However, if the dissection is cautiously performed, the vessel rarely is damaged. In no cases this technique has failed to dissect all arteries, even when the heart anatomy was unfavorable, as in one case of right ventricle hypoplasia, or there were too many fibrous adhesions to the arteries, as in another case. For such, dissection had to be slower and more careful, however the quality of the arteries was not compromised.

DISCUSSION

This technique was shown to be excellent for dissecting the coronary arteries and preventing its histological damaging. It can be performed quickly, safely, and allows both macroscopic and microscopic analyses. As the whole arterial bed comes out as a single piece, the connections between the vessels are not lost. Also, this technique can be used to dissect coronary veins altogether.

There is minimal resection of heart tissue, so that it is similar to a dry riverbed (Figure 2). Once dissection is finished, the heart can be used for any other type of anatomic or pathologic analysis, and it can be opened in the conventional manner (from the posterior to the anterior wall, following the blood flow, first the right side, then the left side).^{2,5}

Very few techniques are described for specific dissection of the coronary arteries,³⁻⁵ but they can be inferred from the methodology of some articles.^{8,9} Asakura et al.⁸ dissected five hearts in order to obtain the coronary arteries and evaluate the flow pattern and spatial distribution of atherosclerotic plaques. The arteries were carefully dissected by using fine scissors and pincers and removing the muscle and surrounding tissues. Only the coronaries and major branches with a diameter greater than 1.5 mm were dissected, and the other branches were ligated with 6.0 prolene. However, there is no mention as to how long it took to perform each dissection, how many hearts were necessary, and how many failures occurred. The arteries were continuously perfused with ice cooled saline, and they could not be removed from their original location, due to the objective of the study.⁸

Fazliogullari et al.⁹ describe their technique as follows: "The epicardium layer was removed by microdissection, and the coronary arteries were observed. All dissections were performed under a dissection microscope (magnification X4) and photographed". The arteries in this case were not removed for the analysis of atherosclerosis, and the connections and possible anatomic variations were only observed in situ. Also, a magnifying glass was used. Fifty hearts were dissected by using their technique, and, as this was not the article's intention, there was also no mention as to failures or duration of the procedure.⁹

Survana³ specifically discusses the use of national guidelines for adult autopsy cardiac dissection. The author says that stepwise transverse slices at no more than 5 mm intervals should be performed (bread-loafing) in order to evaluate atherosclerosis and ponders that the procedure will be more difficult with heavily

calcified vessels. A potential solution is using a scissor, despite they may not only distort or destroy the inner plaque, but also eventual thrombi.³ In our technique, there is no such problem. Once the whole arterial bed is dissected, it may be cautiously cut with a scalpel blade and a forceps. If necessary, sharper blades can be used, and the arteries are more easily held for cutting than if they are kept on the surface of the heart.

Another difficulty in the technique described by Survana³ is that the artery may be sometimes not thoroughly followed, as it may perforate the myocardium or present sudden shifts and changes of caliber. The artery may then be lost, and the whole cardiac surface has to be cut in order to find it again.³ In our technique, however, as the artery is dissected from its end to its origin, it is always complete, and even its perforating branches can be dissected.

Horn et al.,⁴ in accordance with Devin et al.,⁵ affirm that one common, though less crucial mistake in dissection, is routinely bread- loafing and sampling the coronary arteries, when such arteries are abnormal in distribution and morphology. They suggest that the arteries are opened longitudinally, documenting carefully all abnormal origins and patterns of supply.⁴ ⁵ In this case, however, histological analysis of arterial stenosis cannot be performed. If the arteries are completely separated from the heart and analyzed, and even cut transversely, if necessary, for the macroscopic and microscopic analysis of stenosis, the arterial bed can be scrutinized for anatomic variations, anomalies, malformations and the deposition of atherosclerotic plaques.

Anatomic evaluation of the heart arteries is important when performing heart transplantation, especially for congenitally malformed hearts.⁵ Considering the herein technique is fast and needs no magnifying glass, it can be used or adapted to be used in the surgical center. For instance, if it is necessary to evaluate uncommon origins of coronary arteries,

dissection can begin by the aorta rather than by the posterior wall.

We conclude that this dissection technique is specific for the dissection of the arterial bed of the heart for the analysis of atherosclerosis and macroscopic evaluation of the arteries and their possible variations. There is minimal damage to the vessels and the myocardium; both the heart and the adipose tissue can be used for further analyses or dissections; and the technique is fast and can be easily performed during autopsies.

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