

## Location of the Human Sinus Node in Black Africans

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### Abstract

**Objective:** The purpose of this study was to describe, in 45 normal hearts of black Africans adults, the location of the sinoatrial node.

**Methods:** After naked eye observation of the external epicardial area of the sinus node classically described as cavoatrial junction (CAJ), a histological study of the sinus node area was performed.

**Results:** This study concluded that the sinus node is indistinguishable to the naked eye (97.77% of cases), but still identified histologically at the CAJ in the form of a cluster of nodal cells surrounded by abundant connective tissues. It is distinguished from the Myocardial Tissue.

**Conclusion:** The sinus node is located in the cavoatrial junction but, most often, indistinguishable to the naked eye. Therefore, this area should be avoided during cardiac surgery.

**Keywords:** Sinus node; Location

**Abbreviations and Acronyms** CAJ: Cavoatrial junction; AO: Aorta; VCS: Superior vena cava; IVC: Inferior vena Cava; HES: Hematoxylin eosin Safran; MT: Myocardial tissue; SN: Sinus node; SNA: Sinus node area; RA: Right atrial; CT: Crista terminalis

### Background

The sinus node or natural pacemaker was discovered in 1907 by Keith and Flack [1] and bears their name. Its anatomical study was recently taken over by Calmat [2] which clarified its exact situation in an area called "sinus node area". However, recent articles on the anatomical study are rare. Apart Yangni Angate-H [3,4] in Cote d'Ivoire in 1995 and 1999 and Sow [5] in 1996 in Senegal who have studied the vascularization of the sinus node, African studies focusing on the sinus node anatomical description are virtually nonexistent. We deemed it necessary to conduct this study in order to describe the location of sinus node in black Africans.

### Material and Methods

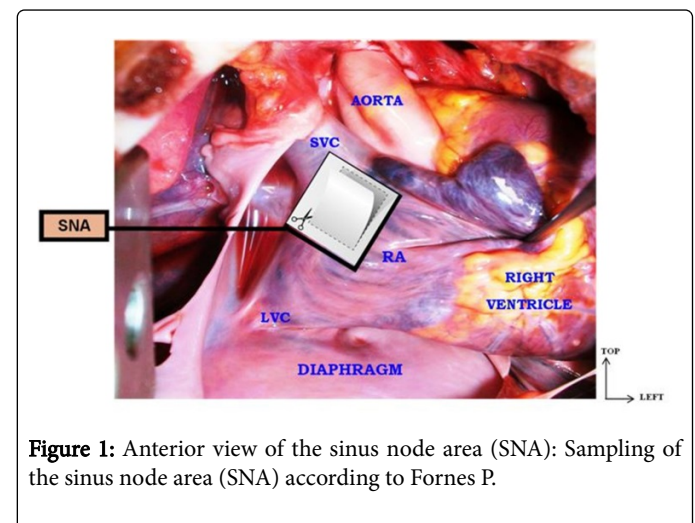
This is a prospective descriptive study of 45 normal hearts taken at autopsy, according to the Ivorian laws in force, in 31 men and 14 women. The average age was 18 years (01 month to 60 years) and the post-mortem period of less than seven months. Hearts were taken by vertical median sternotomy as described by Christides and Cabrol [6] (Opening of the pericardium - Section of the aorta (AO) through two fingers above its base Pulmonary artery section at the source of its two branches Section of the Superior Vena Cava (VCS) to the ending level of the large azygos vein Section of the Inferior Vena Cava (IVC) just above the diaphragm Section of the pulmonary veins as near as possible of the lung hilum. The section of the pericardium at the dead end of Haller, allows the complete removal of the heart). Once the

heart taken, the study was conducted in 2 phases: the macroscopic then microscopic time.

### Macroscopic time

We observed, to the naked eye, the epicardial face of the sinus node area classically referred to as CAJ [1,2] and after sampling of the sinus node area, we observed, to the naked eye, the endocardial face of the sinus node area looking for distinctive signs indicating the presence of the node.

### Microscopic time

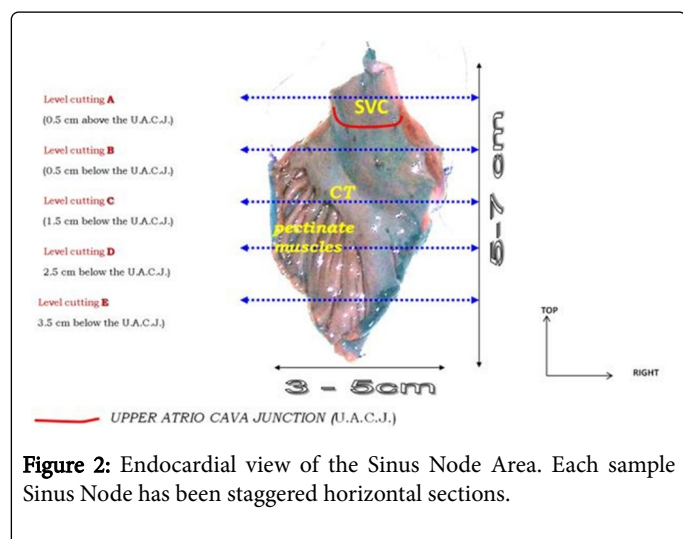


**Figure 1:** Anterior view of the sinus node area (SNA): Sampling of the sinus node area (SNA) according to Fornes P.

We sampled, out of 10 hearts, a portion of CAJ area called "sinus node area" according to the P. Fornes technique [7]. It consists in cutting with scissors, a roughly rhombic portion of the right atrium

(Figure 1), carrying at its upper part, 1cm superior vena cava (SVC), at its lower part, the top end of the right auricle, and both sides of the sulcus terminalis, about 1.5 cm to obtain a sample of 5 to 7 cm × 3 to 5 cm.

The sample obtained was roughly rhombic. Each sample was staggered over horizontal sections from top to bottom of separated 1 cm from each other allowing to obtain 3 to 5 slices with 2 to 3 mm wide and 3 mm thick (Figure 2).



**Figure 2:** Endocardial view of the Sinus Node Area. Each sample Sinus Node has been staggered horizontal sections.

Level A corresponds to the horizontal section of the superior vena cava from 0.5 cm above the CAJ. Level B corresponds to the horizontal section of the region of the sinoatrial node passing at 0.5 cm below the CAJ. Level C is the horizontal section of the sinoatrial node region passing at 1.5 cm below the CAJ. Level D corresponds to the horizontal section of the sinoatrial node the region at 2.5 cm below the CAJ. Level E corresponds to a horizontal section of the sinoatrial node the region at 3.5 cm below the CAJ.

The preparation of histological slides was performed according to the standard method: 10% formalin fixation, dehydration Technicon, inclusion in molten paraffin, histological microtome sections.

Staining was done with Hematoxylin eosin Safran (H.E.S.), the mounting between slides and lamella, and the Reading of the binocular optical microscope at low magnification (2.5X) then at high magnification (40X).

## Results

### Macroscopy

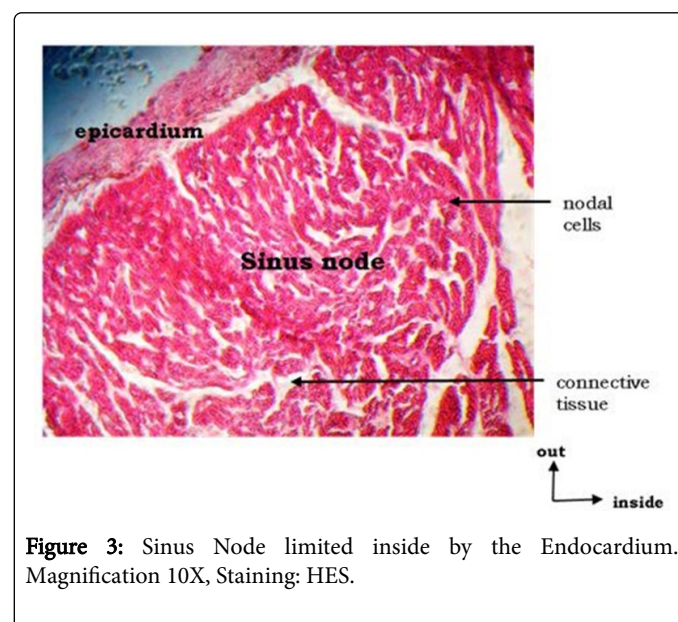
The sinus node was not observable to the naked eye (n=44; 97.77%). In 2.22% of cases, the location in CAJ of its artery or the presence of a thickening of the wall as a bead muscle were the indirect signs of the sinus node situation.

### Microscopy

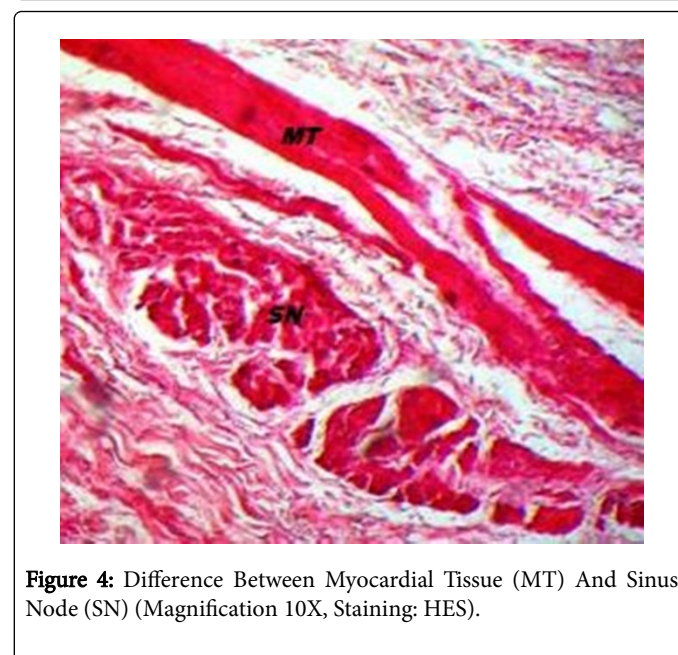
In 100% of cases, histological analysis of the cavoatrial junction (CAJ) area samples, helped to highlight the existence of the sinus node in this area and specify its exact location by a geometric reconstruction technique. The sinus node observed with an optical microscope at a magnification 10X, had in 100% of cases, the appearance of nodal cells

fusiform and entangled in clusters surrounded by abundant connective tissue. It was limited outside by the epicardium (thin cellular layer composed of connective tissue cells) and inside by the endocardium composed of a rich tissue made up with elastic fibers associated with collagen fibers (Figure 3). Sinus node cells were different from the myocardial tissue cells which were elongated cells surrounded by a sparse connective tissue (Figure 4).

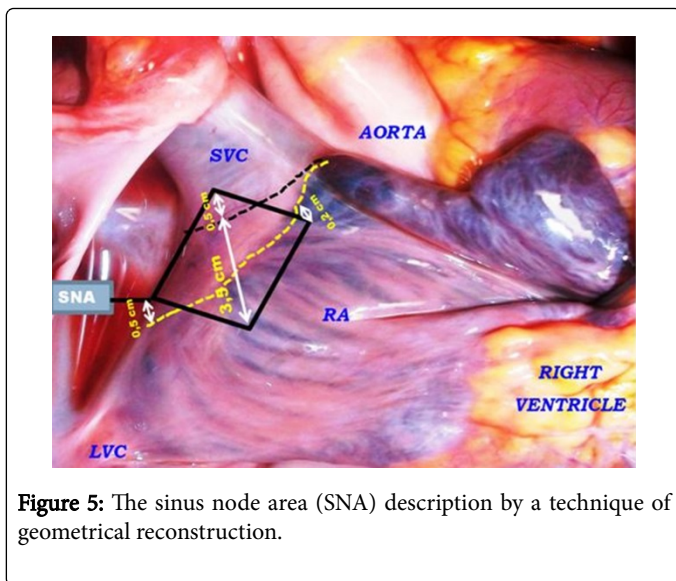
The sinus node was observed once at the level of Section A (which was of ectopic sinus node location), 4 times at the level B, 3 times at levels C and D and 2 times at the level E. This histological observation of the sinus node, according to the levels of cuttings, allowed specifying its right location by the geometrical reconstruction technique. Thus, we hold that the sinus node, in the black African, is located in a portion of the right atrium, roughly rhombic in the cavoatrial junction, limited by four points (Figure 5):



**Figure 3:** Sinus Node limited inside by the Endocardium. Magnification 10X, Staining: HES.



**Figure 4:** Difference Between Myocardial Tissue (MT) And Sinus Node (SN) (Magnification 10X, Staining: HES).



**Figure 5:** The sinus node area (SNA) description by a technique of geometrical reconstruction.

The upper point was projected to 5 mm above the cavoatrial junction, the lower point was projected on the right atrium to 4 mm below the incisura, The straight point was in the right part of the sulcus terminalis, at 20 mm from the incisura, the last left point, was on the left side of the sulcus, at 5 mm from the incisura.

## Discussion

Our method has similarities to that used by some authors such as Reginald Hudson [8] in 1960, Davies [9] in 1972 and Kenneth Anderson [10] in 1979, all in Britain, which after removal of the sinoatrial node, made vertical cuts for the first two, and mixed, vertical and cross-sections for the last.

As for Dr. Arthur Keith Martin and Mr. Flack [1] in 1907, in London, they realized vertical cuts in the sinoatrial node area without considering, first, the area.

At the macroscopic level, in our study, the sinus node was indiscernible to the naked eye observation of the right atrium at the cavoatrial junction as demonstrated by Reginald Hudson [8] in 1960. However, the wall thickening, observed at the endocardial surface of the sinus node area and the sinus node artery found to the naked eye in this area, are not described in the literature, they could be considered significant indirect signs of the presence of sinus node.

At the microscopic study, the appearance of the sinus node observed with an optical microscope at low magnification (aspect of tangled and fusiform cells grouped in clusters, surrounded by an abundant connective tissue) was similar to that described by P Hadjiisky [11] in 1989 and Fornes [12] in 2006. In addition, these sinus node cells, in our study differed from other atrial cardiomyocytes (elongated appearance, joined together by a joining system describing scarlatiniiform streaks, surrounded by very rare connective tissue) as observed by the same authors. These histological observations, according to the levels of cuttings performed in the cavoatrial junction (CAJ) allowed us to locate the black African sinus node in the atrial wall, under the epicardium, limited outside by the epicardium and inside by the endocardium in a roughly rhombic portion of the right atrium located in the cavoatrial junction. These observations were similar to those described by R E B Hudson [13] in 1967 in England;

Kenneth [10] in 1979 in New Zealand, Damián Sánchez-Quintana [14], in 2015 in Spain and Anderson [15], in 2003 in England.

Because of this location, the sinus node is in sort of danger during heart surgery. The atrial incision may divide it; the superior vena caval tourniquet may damage it; it may be crushed by forceps; or it may be involved in suturing [8]. After orthotopic heart transplantation by standard biatrial anastomosis, the atrial surgery which involves substantial incision and suturing of the donor's anterior right atrial wall has the potential to disturb the sinus node and produce an arrhythmogenic substrate [16]. Even with a bicaval technique (variation of the standard heart transplantation procedure), the sinus node dysfunction can be caused by surgical trauma at the time of transplantation with sinus arrest after heart transplantation [17]. Furthermore, postoperative inflammation related to the development of clinically-evident or silent pericarditis can irritate the sinus node and cause Postoperative Arrhythmias after Cardiac Surgery [18].

## Conclusion

Among black African and non-African subjects; the sinus node is located in the cavoatrial junction. It is most often indiscernible to the naked eye. Therefore, the cavoatrial junction is a dangerous area to avoid during straight atriotomies, upper atrio-caval cannulations, and other manipulations in the course of cardiac surgery under Extra-Corporeal Circulation or not; because any lesion of this area may cause damage to the Sinus node and bring about arrhythmias.

## Acknowledgements

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## Central Message

The sinus node is located in the cavoatrial junction but not visible to the naked eye. This area should be avoided during heart surgery.

## Perspective Statement

The Sinoatrial node is most often indiscernible to the naked eye. Therefore, the cavoatrial junction is a dangerous area to avoid during straight atriotomies, upper atriocaval cannulation and other manipulations during cardiac surgery under Extra-Corporeal Circulation or not. Every lesion of this area may cause damage to the Sinoatrial node responsible for arrhythmias.

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