

A Study of the Sinu-atrial Nodal Artery in the Nepalese Cadavers

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Abstract: Cardiac problems are encountered in the clinic more nowadays. Many of the cardiac problems and procedures have impact on the Sinu-atrial nodal artery which is the pace-maker of the heart. Variations of Sinu-atrial nodal artery and its knowledge is must in understanding cardiac problems and conducting clinical practices. Thirty hearts from the cadavers were taken for the study. The hearts were dissected, Sino-atrial nodal artery were exposed and analyzed. Sinu-Atrial nodal artery did not arise from arteries other than the right coronary artery. The level of origin differed in different specimens. In 10% of the specimens, it originated from the length interval of 6-10 mm, in 40% from the length interval of 11-15 mm, in 23.33% from the length interval of 16-20 mm, in 13.33% from the length interval of 21-25 mm and in 10% from the length interval of 26-30 mm from the origin of right coronary artery. In one of the specimen it was found to originate from the right coronary artery at a length of 55mm from its origin which was near the inferior margin of the heart. The course was retrocaval in all of the specimens. No extra origin of the artery was found.

Keywords: Right coronary artery, Left coronary artery, Sino-atrial Nodal artery, Sinu-atrial Node.

INTRODUCTION

Cardiac complications are encountered more in the clinic nowadays because of the changing life styles. Variations in the Sinu-atrial nodal artery have impact on cardiac problems and clinical approaches.

So, knowledge regarding its variations in origin, number and course is must in understanding the various cardiac problems and in conducting clinical/surgical practices.

Coronary arteries supply the blood to the heart [1]. Two primitive endothelial tubes which represent the ventral aorta fuse and develop as a heart that's why these are the vasa vasorum of the ascending aorta [2, 3]. The blood supply of the whole body and heart itself is all dependent on the heartbeat. The heart beats ceaselessly for many decades and maintain the perfusion of pulmonary and systemic tissues [4]. It originates in a specialized cardiac conduction system and spreads via this system to all the parts of the myocardium [5]. Various parts of the conducting system are capable of discharging but the SA node normally discharges most rapidly before they do spontaneously [5]. So, the SA node is called as the pace-maker of the heart [5] which is located at the junction between parts of the right atrium derived from the embryonic venous sinus and atrium proper [4]. Its rate of discharge

determines the rate at which the heart beats [5]. The blood supply of SA node is most essential which is supplied by the SA nodal artery [1]. SA nodal artery arises from the right coronary artery [1] but its origin, number and course is found variable [6] which may come from the circumflex (CMX) branch of Left coronary artery (LCA) or both coronary arteries [6, 7]. The frequency of SA nodal artery originating from RCA is more than the left and when it is from left it's more frequently from CMX branch than from the main trunk of the LCA [8]. A posterior sinus node artery and an accessory atrio-ventricular (AV) nodal artery are also reported to originate from a common trunk branching from the posterior segment of the CMX branch [9]. Blood supply to SA node from arteries other than the coronary arteries is not seen [8]. There is no any relation between the origin of the SA nodal artery and coronary dominance [10]. The level of origin from RCA also varies being proximal 40 mm of the right coronary artery (RCA) and from the proximal 35 mm of the left CMX branch [11], arising at a mean distance of 1.2 cm (range 0.2-2.2 cm) from its beginning [10]. The

presence of single and dual blood supply to the SA node is also seen. The course of SA nodal artery approaching the nodal tissue is found to be by one of the three routes- retrocaval, precaval, or pericaval [11]. Posterior SA nodal artery arising from the CMX branch is also found to course around the posterior, lateral, and finally anterior wall of the left atrium to the sinus venosus, giving off a branch to the SA node from posteriorly [9]. Racial and sex factors have no influence on the anatomical variations [8]. The present study was designed to find the prevalence of variations related to the SA nodal artery particularly its origin, number and course in the Nepalese cadavers.

MATERIALS AND METHODS

Thirty hearts were taken for the study. They were dissected out from the cadavers during the routine laboratory exercises conducted for the undergraduate students at the Nobel Medical College, Biratnagar, Nepal during the period from 2013-2017. The hearts were dissected, the coronary arteries and SA nodal artery were exposed out and the study was done. The parameters used in the study were particularly its origin, number and course.

Inclusion criteria

Fresh undissected hearts were used for the study whereas the dissected and damaged hearts were excluded.

RESULTS

SA nodal artery originated from the right coronary artery in all the specimens. It wasn't found originating from any other arteries. It originated at an

average mean length of 20 mm from the beginning of the RCA. However, the level of origin differed in different specimens. In no specimens was the SA nodal artery found to arise from near the origin (0-5mm of the length from the beginning) of the RCA whereas in 10% it was found to arise from the length interval of 6-10 mm from the origin of RCA. In most of the specimens the SA nodal artery originated from RCA at a length of 11-15 mm from its beginning. Origin from this interval of length constituted 40% of the total specimens. In 23.33% of the specimens it was found to arise from the interval of 16-20 mm of the length of RCA from its beginning. In 13.33% the SA nodal artery originated from the interval of 21-25 mm of the length of RCA from its origin. In 10% it was found to arise from the length interval of 25-30 mm of RCA from its origin. Strikingly in one of the specimen the SA nodal artery was found to vary than the other normal origin. It originated from near the inferior margin of the heart which was at a length of 55 mm from the origin of the RCA. Calibre of the artery was also high with an external diameter of 2 mm. It ascended in the coronary groove and coursed to reach and supply the SA node.

The course of the SA nodal artery arising at lower level relatively was normally in the coronary groove which ascended upward. The SA nodal artery arising at higher level i.e. near the origin of RCA was coursing just laterally and posteriorly. They approached the SA node with a retrocaval course (from behind the superior venacava) in all of the specimens. No dual or extra origin was found, only single origin of SA nodal artery was found in the study.

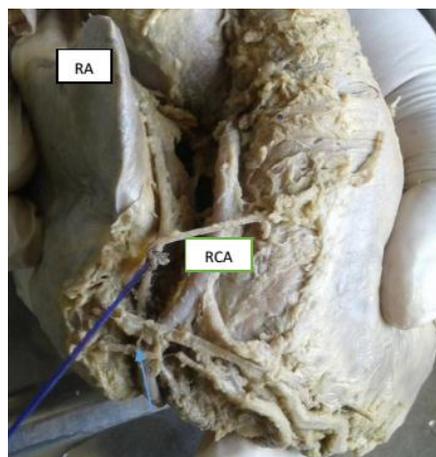


Fig-1: SA nodal artery tied with thread (arising from RCA at the level near the inferior margin of the heart (Arrow head))

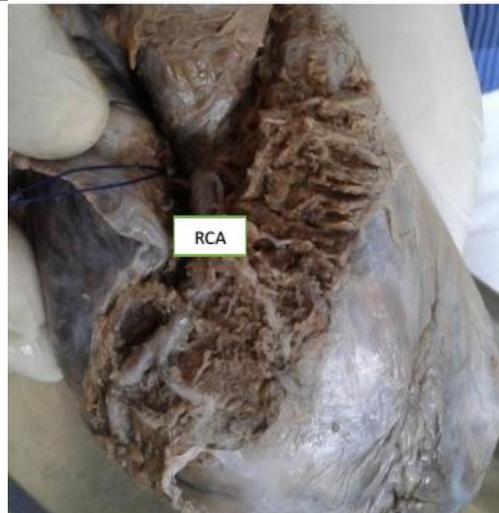


Fig-2: SA nodal artery (tied with thread) arising from RCA near its origin and having a retrocaval course

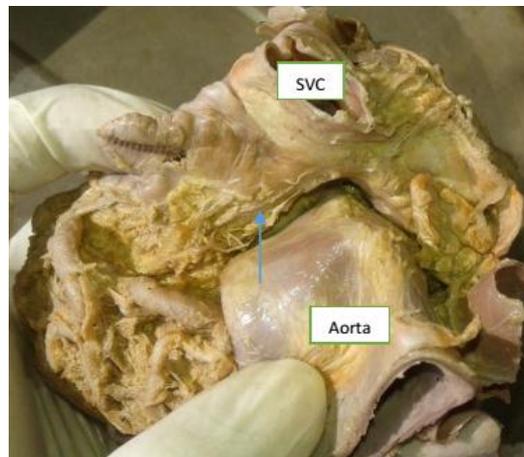


Fig-3: SA nodal artery (arrow head) having retrocaval course



Fig-4: SA nodal artery (tied with thread) arising from RCA near its origin and having a retrocaval course

DISCUSSIONS

Changing life styles has created different health complications in all the aspects. Cardiac problems too have been encountered more nowadays.

Advancement in science and technology, however, has made easy in clinical approaches but still there are some complications behind due to anatomical variations of

SA nodal artery. The variations are most frequently seen with its origin, number and course.

SA nodal artery originated from the right coronary artery in all the specimens. It wasn't found originating from any other arteries, but it doesn't mean that variations are not present as because variations in the origin have been reported in different study done in different places by different authors. A meta-analysis done by Vikse J *et al.* reported to arise from RCA in 68%, from CMX branch and LCA itself with a pooled prevalence of 22.1% and 2.7% respectively[12]. A study done in South Indians by Ramanathan L *et al.* shows the SA (sinoatrial) node supplied by the RCA in

53% of the cases, by CMX branch in 42.66%, and by both coronary arteries in 4.33% of the cases[7]. In another study done by Pejkočić B *et al.* the SA nodal artery arose in 63% of the cases from RCA whereas in 37% it arose from the LCA or one of its branches [10]. Similarly in the study done by Caetano AG *et al.* it is reported to arise from RCA in 58% of the cases, from CMX in 30% and from LCA itself in 12% of the cases[8]. A study in the Korean population done by Song YS *et al.* shows the SA nodal artery arising from RCA in 53.4% and from CMX branch in 43% of the cases[13] which is similar to the study done by Ramanathan L *et al.* Table 1 shows the comparison of the origin of SA nodal artery in different studies.

Table-1: Origin of the SA nodal artery as reported in different studies

Authors	Origin from RCA	Origin from CMX branch	Origin from LCA	Origin from both
Saremi F <i>et al</i> [11]	65.68%	27.45%	-	5.88%
Ramanathan L <i>et al</i> [7]	53%	42.66%	-	4.33%
Song YS <i>et al</i> [13]	53.4%	43%	-	-
Present study	100%	-	-	-

The level of origin of SA nodal artery also varies as reported by different authors. Pejkočić B *et al.* reported in their study that SA nodal artery arose from RCA at a mean distance of 12 mm with a range of 2-22 mm [10]. Saremi F *et al.* reported that the SA nodal artery arose from proximal 40 mm of the RCA and proximal 35 mm of the CMX branch [11]. In the meta-analysis done by Vikse J *et al.* the pooled mean distance of the origin of SA nodal artery from the ostium was 16.306 mm and origin of SA nodal artery from the ostium of LCA was 14.323mm [12] whereas Ozturk E *et al.* reported that the mean distance between the origin of the SA Nodal artery from RCA and the RCA ostium was 16.2 mm and, from Left circumflex and the origin of Left circumflex was 19.3 mm [14]. However, the level of origin in the present study differed in different specimens. SA nodal artery originated at an average mean distance of 20 mm from the origin of the RCA which is more than reported in any other study. In no specimens was the SA nodal artery found to arise from near the origin (0-5mm length interval from the origin) of the RCA whereas in 10% it was found to arise from the length interval of 6-10 mm from the origin of RCA. In most of the specimens the SA nodal artery originated from RCA at a length of 11-15 mm from its beginning

which is similar to the mean distance as reported by Pejkočić B *et al.* Origin from this interval of length constituted 40% of the total specimens. In 23.33% of the specimens it was found to arise from the interval of 16-20 mm of the length of RCA from its origin in which the mean distance as reported by Ozturk E *et al.* also lies. In 13.33% the SA nodal artery originated from the interval of 21-25 mm of the length of the RCA from its origin. In 10% it was found to arise from the length interval of 25-30 mm of RCA from its origin. By the present study it shows that the origin of the SA nodal artery from the length interval of 21-30mm is comparatively less but not rare. This is similar to as reported in other study. Strikingly in one of specimen the SA nodal artery was found to vary than the other normal origin. It originated from near the inferior margin of the heart which was at a length of 55 mm from the origin of RCA. Study reporting the origin of SA nodal artery at this level is very rare. Calibre of the artery was high with an external diameter of 2 mm. It ascended in the coronary groove and coursed to reach and supply the SA node. Okmen AS *et al.* found in 0.8% of the subjects in which SA nodal artery arose from postero-lateral branch of RCA as reported in their study [15].

Table-2: Mean distance between the origin of SA nodal artery from the beginning of RCA and LCA

Authors	From the origin of RCA	From the origin of LCA
Pejkočić B <i>et al.</i>	12 mm	-
Vikse J <i>et al.</i>	16.306 mm	14.323 mm
Ozturk E <i>et al.</i>	16.2 mm	19.3 mm
Present study	20 mm	-

Table-3: Prevalence percentage of the origin of SA nodal artery at different length interval from the origin of the RCA in the present study

Length interval	6-10 mm	11-15 mm	16-20 mm	21-25	26-30 mm	Rare case (55 mm)
Percentage	10%	40%	23.33%	13.33%	10%	3.33%
Average mean distance	20 mm					

The variations in the number of SA nodal artery is also found in different study. Caetano AG *et al.* didn't find any extra SA nodal artery or SA nodal artery arising from both coronary arteries[8]. Similar was the result as studied by Berdajs D *et al* [16] But in the meta-analysis done by Vikse J *et al.* it showed the duplication and triplication of SA nodal artery with a pooled prevalence of 4.3% and 0.3% respectively [12]. The study done by Ozturk E *et al.* shows a single artery in 96% of the cases whereas in 4% there were two arteries[14]. In another study done by Shimotakahara R *et al.* the SA nodal artery was found to have one branch in 91.2% of the specimens, two branches in 8.5%, and three branches in 0.3% specimen [17]. However in the present study no dual or extra origin was found, only single origin of SA nodal artery was found in the study.

The course of the SA nodal artery is also seen to vary as reported by different study. Tanaka S *et al.* reported a case in a Japanese male cadaver, in which a common trunk branching from the posterior segment of the CMX branch gave rise to posterior sinus node artery and an accessory AV nodal artery. The posterior sinus node artery coursed in clockwise direction around the posterior, lateral, and finally anterior wall of the left atrium to the sinus venosus, giving off a branch to the SA node from posteriorly [9]. In the study done by Berdajs D *et al* the SA nodal artery crossed the superior posterior border of the interatrial septum in 54% of cases [16]. Zhang LJ *et al.* found in their study to have the artery with retrocaval course in 51.5%, precaval in 25.2% and pericaval in 22.3% [18]. In another study done in 25 infant human hearts; Anderson KR *et al.* found in 11 hearts the artery approached posteriorly, and in 10 the artery approached anteriorly [19]. Surprisingly in the present study all of the SA nodal artery approached the SA node with a retrocaval course in all of the specimens.

Sex and race didn't influence the anatomical variations[8,20]. In the present study no relation was found between the anatomical variations of SA nodal artery and the coronary dominance which is also reported by Pejčković B *et al.*[10].

CONCLUSION

The SA nodal artery mostly arose from the RCA in the Nepalese cadavers but the level of origin varied. Normally a single SA nodal artery is present. The course was retrocaval. But, considering other literature, it can't be neglected that origin could be from other sites, or the number and course could be different,

otherwise, it can/may be disastrous during clinical approaches.

Abbreviations

RCA: Right Coronary Artery; LCA: Left Coronary Artery; CMX branch: Circumflex branch of Left Coronary Artery; SA node: Sinu-atrial node; AV node: Atrio-ventricular node; SA nodal Artery: Sinu-atrial nodal artery, RA: Right Auricle, SVC: Superior venacava

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REFERENCES

1. Marieb, E. N., & Hoehn, K. (2007). Human anatomy & physiology. Pearson Education.
2. Agur, A. M., & Dalley, A. F. (2009). *Grant's atlas of anatomy*. Lippincott Williams & Wilkins.
3. Gössl, M., Rosol, M., Malyar, N. M., Fitzpatrick, L. A., Beighley, P. E., Zamir, M., & Ritman, E. L. (2003). Functional anatomy and hemodynamic characteristics of vasa vasorum in the walls of porcine coronary arteries. *The anatomical record*, 272(2), 526-537.
4. Standring, S., Ellis, H., Healy, J., Johnson, D., Williams, A., Collins, P., & Wigley, C. (2005). Gray's anatomy: the anatomical basis of clinical practice. *American Journal of Neuroradiology*, 26(10), 2703.
5. Barrett, K. E. (2010). Ganong's review of medical physiology.
6. Cezlan, T., Senturk, S., Karcaaltıncaba, M., & Bilici, A. (2012). Multidetector CT imaging of arterial supply to sinoatrial and atrioventricular nodes. *Surgical and radiologic anatomy*, 34(4), 357-365.
7. Ramanathan, L., Shetty, P., Nayak, S. R., Krishnamurthy, A., Chettiar, G. K., & Chockalingam, A. (2009). Origin of the sinoatrial and atrioventricular nodal arteries in South Indians: an angiographic study. *Arquivos brasileiros de cardiologia*, 92(5), 342-348.
8. Caetano, A. G., Lopes, A. C., DiDio, L. J., & Prates, J. C. (1995). Critical analysis of the clinical and surgical importance of the variations in the origin of the sinoatrial node artery of the human heart. *Revista da Associação Médica Brasileira* (1992), 41(2), 94-102.

9. Tanaka, S., Lee, H. Y., Mizukami, S., Nakatani, T., & Chung, I. H. (1998). Posterior sinus node artery and accessory atrioventricular node artery arising by a common origin: a case report. *Clinical Anatomy*, 11(2), 106-111.
10. Pejčković, B., Krajnc, I., Anderhuber, F., & Košutić, D. (2008). Anatomical aspects of the arterial blood supply to the sinoatrial and atrioventricular nodes of the human heart. *Journal of International Medical Research*, 36(4), 691-698.
11. Saremi, F., Abolhoda, A., Ashikyan, O., Milliken, J. C., Narula, J., Gurudevan, S. V., ... & Raney, A. (2008). Arterial supply to sinoatrial and atrioventricular nodes: imaging with multidetector CT. *Radiology*, 246(1), 99-107.
12. Vikse, J., Henry, B. M., Roy, J., Ramakrishnan, P. K., Hsieh, W. C., Walocha, J. A., & Tomaszewski, K. A. (2016). Anatomical variations in the sinoatrial nodal artery: A meta-analysis and clinical considerations. *PloS one*, 11(2), e0148331.
13. Song, Y. S., Lee, W., Park, E. A., Chung, J. W., & Park, J. H. (2012). Anatomy of the sinoatrial nodal branch in Korean population: imaging with MDCT. *Korean journal of radiology*, 13(5), 572-578.
14. Ozturk, E., Saglam, M., Bozlar, U., Sivrioglu, A. K., Karaman, B., Onat, L., & Basekim, C. C. (2011). Arterial supply of the sinoatrial node: a CT coronary angiographic study. *The international journal of cardiovascular imaging*, 27(4), 619-627.
15. Ökmen, A. S., & Ökmen, E. (2009). Sinoatrial node artery arising from posterolateral branch of right coronary artery: definition by screening consecutive 1500 coronary angiographies/Sag koroner arter posterolateral dalından çıkan sinoatriyal nod arteri: Ardisik 1500 koroner anjiyografi taramasi ile tanimlama. *Anadolu Kardiyoloji Dergisi: AKD*, 9(6), 481.
16. Berdajs, D., Patonay, L., & Turina, M. I. (2003). The clinical anatomy of the sinus node artery. *The Annals of thoracic surgery*, 76(3), 732-735.
17. Shimotakahara, R., Shimada, K., & Kodama, K. (2014). Anatomical study on the sinoatrial nodal branch in the human coronary artery. *Anatomical science international*, 89(2), 79-84.
18. Zhang, L. J., Wang, Y. Z., Huang, W., Chen, P., Zhou, C. S., & Lu, G. M. (2008). Anatomical investigation of the sinus node artery using dual-source computed tomography. *Circulation Journal*, 72(10), 1615-1620.
19. Anderson, K. R., Ho, S. Y., & Anderson, R. H. (1979). Location and vascular supply of sinus node in human heart. *Heart*, 41(1), 28-32.
20. DiDio, L. J. A., Lopes, A. C., Caetano, A. C., & Prates, J. C. (1995). Variations of the origin of the artery of the sinoatrial node in normal human hearts. *Surgical and Radiologic Anatomy*, 17(1), 19-26.