CARDIAC ARRHYTHMIAS IN RELATION TO ELECTROLYTE DISTURBANES IN ACUTE MYOCARDIAL INFARCTION

THESIS

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By

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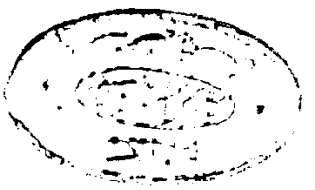

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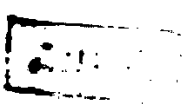

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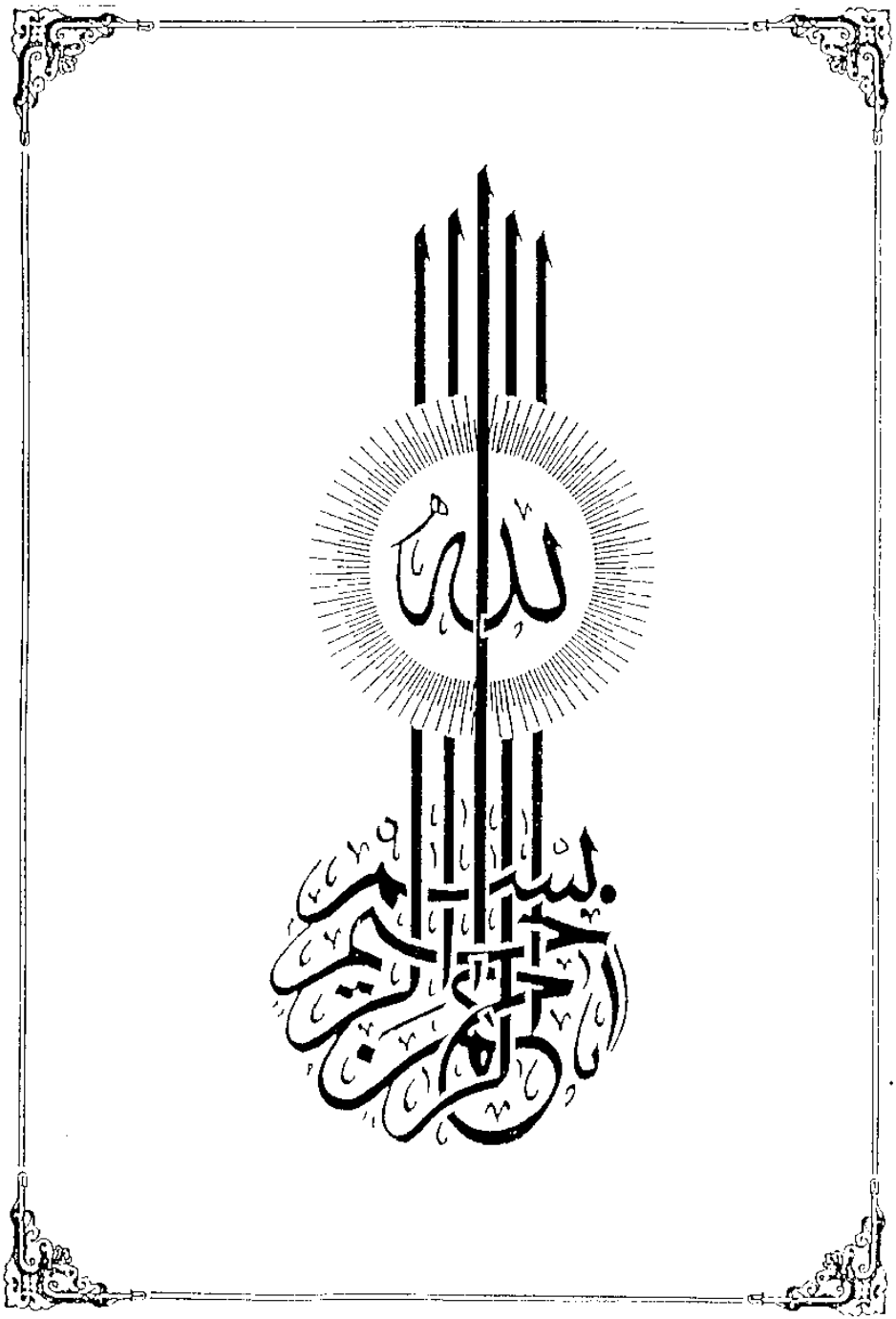

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ANATOMY OF THE CONDUCTION SYSTEM

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The sinus node is located at the lateral aspect of the superior vena caval right atrial junction posterior to the crest formed by the union of the right atrial appendage with the superior vena cava. Its dimensions along the line of the sulcus terminalis ranges from 10-20 mm, while its dimension perpendicular to this line (parallel to the epicardium) is about 5mm in its mid portion. Its maximal endocardial-epicardial dimension is about 1.5 mm, (Hudson, 1960; James, 1961., and James et. al., 1966).

By the naked eye the sinus node can be seen as a pale collagenous zone around the sinus node artery, located above the crista terminalis,less than 1 mm beneath the epicardium.

Microscopically the sinus node is formed of arranged collagen and elastin framework which surrounds and adherent to the sinus node artery. The nodal cells form an interweaving mesh within this framework. There are two principal types of nodal cells: P cells and transitional cells (James et, al. 1966). P cells are centrally located and connected with one another and with transitional cells.

They are small, pale and round with a large nucleus, few organelles and sparse randomly oriented myofibrils. Transtional cells are small, pale and slender, with a large number of longitudinally oriented myofibrils. Transitional cells are connected with one another, with P cells and with purkinje cells which are present at the margin of the sinus node.

THE INTERNODAL PATHWAYS:

James (1963) has documented the presence of three pathways connecting the sinus and AV nodes. Conduction velocity through these paths has been demonstrated to be more rapid than in working atrial myocardium (Goodman et. al. 1971).

The anterior internodal pathway exits anteriorly from the sinus node and travels in front of the superior vena cava to enter the anterior inter atrial myocardial band (Bachmann's bundle).

The middle internodal pathway is less well developed in man. It exits from the sinus node posteriorly, travelling behind the superior vena cava to enter the upper interatrial septum posterior to the anterior pathway. As

the middle internodal pathway courses within the septum it interconnects with the anterior pathway in the region of the anterior rim of the fossa ovalis before both groups of fibers enter the crest of the AV node.

The posterior pathway exits from the sinus node posteriorly to travel in the crista terminalis, swinging from it into the Eustachian ridge and from there passes just above the coronary sinus to connect with the AV node at its posterior margin. The three internodal pathways interconnect near the crest or upper margin of the AV node.

THE AV NODE:

The AV node lies within the interatrial septum just above the attachment of the septal leaflet of the tricuspid valve. Its posterior margin is less than 1 mm from the ostium of the coronary sinus. Its dimensions are about 1-3 mm, but there is considerable variation. The AV node consists of interweaving connections of P cells and transitional cells (James and Sherf, 1968). Transitional cells are slightly thiker and shorter than those of the SA node. P cells are fewer in number. There is a large number of nerves and cholinergic ganglia in the fat posterior to the AV node near the ostium of the coronary sinus.

THE HIS BUNDLE:

The AV node connects anteriorly with the His (AV) bundle, which penetrates the right side of the central fibrous body and continues within it anteriorly and inferiorly. In man this bundle is the only pathway for transmission of the electrical impulse from atrium to ventricle. There is no distinct border between the randomly oriented AV nodal architecture and the more orderly arranged His bundle. The His bundle is composed almost entirely of strands of purkinje cells arranged in parallel rows, separated by fine collagen septa, with only sparse interconnections between the rows (Sherf and James, 1959).

The His bundle courses within the central fibrous body along the postero-inferior margin of the membranous interventricular septum to reach the summit of the muscular septum. In its course the His bundle is in close proximity to the posterior (noncoronary) cusp of the aortic valve. Upon reaching the muscular interventricular septum the His bundle begins to give off a continuous sheet of fibers to the left septal subendocardial surface. At a variable point more anteriorly the His bundle provides

a single slender right bundle branch. A small and variable group of fibers connect the His bundle and proximal left bundle branch to the muscular interventricular septum (Mahaim's paraspecific fibers).

BUNDLE BRANCHES

The right bundle branch is a long, thin, well circumscribed group of fibers, with few (or no) proximal branches. In its initial few millimeters it is oriented anteriorly, sometimes in a subendocardial position, but often deeply placed in septal myocardium. As the right bundle branch approaches the papillary muscle of conus (muscle of Lancisi) it curves inferiorly, most frequently taking an intramyocardial course in the inferior margin of the septal band. Distally the right bundle branch leaves the septum and enters the moderator band forming several divisions as it reaches the papillary muscle of the right ventricle.

The left bundle branch may be more accurately considered a sheet than a cylindrical branch. Unlike the cylindrical right bundle branch, the broad system of left bundle branches consists of a group of fibres which leaves the His bundle forming poorly delineated and highly variable

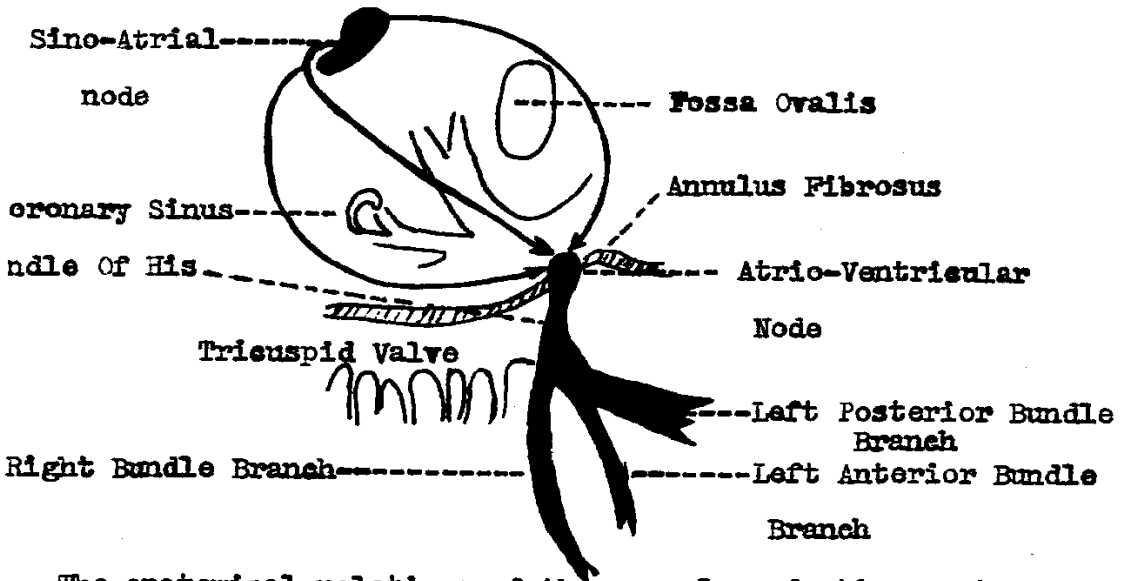
divisions fanning out over the left interventricular septal subendocardium with two of the many divisions forming relatively direct connections to the anterior and posterior papillary muscle. The anterior division is long and thin, lying below the aortic valve in the left ventricular outflow tract. The posterior division is much thicker and shorter, lying mostly in the left ventricular inflow tract. From the anatomical point of veiw it is apparant that a relatively small lesion can interrupt the right bundle branch, while it requires a moderately sized lesion to interrupt the left bundle branch system near the His bundle, and a massive septal lesion to interrupt this system distally.

Both the left and right bundle branches, like the internodal pathways, contain two populations of cells. Purkinje cells and cells appearinglike working myocardium In some locations the Pukinje cells are smaller than working myocardial cells, but in others they are larger and there appears to be no consistent pattern for this variation. There are cholinergic nerve endings in the His bundle and bundle branches, but nc ganglia.

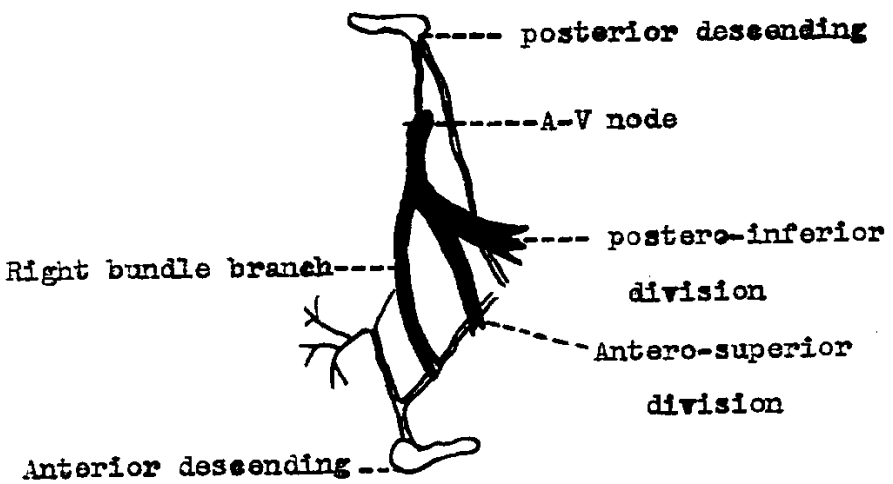
BLOOD SUPPLY OF THE CONDUCTION SYSTEM

The sinus node artery is about 1 mm in diameter originates from the first few centimeters of the right coronary artery in about 55% of human hearts and from first few millimeters of the left circumflex artery in about 45% (James and Burch, 1958a). When it originates from the right coronary, it sends a large branch to the left atrium through the Bachmann bundle and when the artery originates from the circumflex it gives off its left atrial branches and travels to the sinus node through Bachmann's bundle. The sinus node artery supplies the majority of the right atrium including the internodal pathways except for area of the Eustachian ridge (through which runs the posterior internodal pathway) which is primarily perfused by the branches of AV node artery (James and Burch, 1958a). There are anastomosis up to several hundered microns in diameter between the sinus node artery and the small atrial branches of the right and left coronary (James and Burch, 1958a; James, 1970).

The AV node artery is a branch of the right coronary in 90% and the left coronary in 10%. It originate at the apex of the U turn that the parent artery makes as it goes under the posterior interventricular vein. The AV node



The anatomical relations of the normal conduction system.



A diagramatic representation of the blood supply to the atrioventricular node and the conducting system.

ELECTROPHYSIOLOGIC BASIS OF ARRHYTHMIAS