# Left Bundle Branch Block (LBBB) and left His System

**Concept:** LBBB, left His system global block or left ventricle global block, is any delay in left ventricle (LV) activation as a consequence of a dromotropic disorder located in one or more of the following sites:

#### I ) Proximal, predivisional or membranous

- 1. Left His bundle
- 2. Stem (truncus) of Left Bundle Branch of His bundle (LBB): 1 and 2 are known as pre-

divisional, stem or membranous LBBB.

#### ${\bf II}$ ) Divisional or fascicular

3. Fascicles or divisions of LBB of the His bundle concomitantly: left anterior fascicle (LAF),

left posterior fascicle (LPF), and left septal or middle-septal fascicle (LSF); This type is known as

fascicular or divisional LBBB.

#### III ) Intramyocardial or Purkinje-muscle

4. Left Purkinje globally approached: This is known as parietal, Purkinje, intramural or

## **Outline of the three portions in the LBBB and nomenclature of the** intraventricular His System

- Troncular or predivisional LBBB: V-VI 1.
- Divisional or fascicular LBBB: VIII, IX, X 2.
- 3. Purkinje-muscle LBBB: XI

I.

II.

V.

X.





#### **Outline that shows the CLBBB according to topography**



- I. Penetrating portion of left His bundle
- II. Stem or truncus of LBB
- III. Right Bundle Branch (RBB)
- IV. Left Anterior Fascicle (LAF)
- troncular or membranous LBBBs

Blocks in I and II are called predivisional,

V. Left Posterior Fascicle (LPF) Blocks in IV+V+VI are called divisional or fascicular LBBB VI. Left Septal Fascicle (LSF) The LBB arises inferior to the membranous septum between the right and non-coronary aortic cusp. The LBB is a thick band like structure, takes an immediate subendocardial course on the left side of the septum and typically branches out in a trifascicular pattern into a LSF, LAF and LPF (Tawara 1906)(1). The LSF supplies the mid-septal area and arises most commonly from the main trunk but can also arise from the LAF or LPF or from a complex plexus of network originating from anterior and posterior fascicle.(2;3) The LAF is a thin and long structure that traverses towards the antero-lateral papillary muscle. The LPF is a thick, broad and short structure that traverses towards the postero-medial papillary muscle (At the base of the papillary muscles, the fascicles branch out into an extensive network of Purkinje fibers with rich intercommunications that supply the LV subendocardium. There is considerable variation in the size, number, and distribution of the LBB in the human hearts.

- 1. Tawara S. Das Reizleitungssystem des Säugetierherzens. Eine Anatomisch-Histologische Studie Über das Atrioventrikularbün- del und die Purkinjeschen Fäden. Jena, Gustav Fischer. Published online 1906.
- 2. Santosh K Padala 1, José-Angel Cabrera 2, Kenneth A Ellenbogen 1 Anatomy of the cardiac conduction system.Pacing Clin Electrophysiol . 2021 Jan;44(1):15-25. doi: 10.1111/pace.14107.
- 3. José-Ángel Cabrera 1, Andreu Porta-Sánchez 1 2, Roderick Tung 3, Damián Sánchez-Quintana 4Tracking Down the Anatomy of the Left Bundle Branch to Optimize Left Bundle Branch Pacing. JACC Case Rep. 2020 Apr 27;2(5):750-755. doi: 10.1016/j.jaccas.2020.04.004.

### Characteristics of the structural components of predivisional CLBBB

- I. Penetrating portion of left His bundle
  - **Systematization:** longitudinal
  - Length: 75 mm (50 to 100mm)
  - Neighboring structures: fibrous trigone, mitral-aortic rings and membranous septum.
- II. Truncus of Left Bundle Branch (LBB)
  - Length: 10 mm (five times shorter than the **RBB**).
  - **Diameter:** in its onset 5 mm and at the end 9 mm (four to eight times longer than the **RBB**).
  - Color: white.
  - Cell type: Purkinje. These are large cells of 15 to 30 mm of diameter and 20 to 100 mm of length.
  - **Conduction velocity:** 5 m/sec (fast fibers)
  - **Characteristics of Action Potential (AP):** fast fiber type, Na<sup>+</sup> dependent, phase 4 with automatism (diastolic depolarization) and with a refractory period shorter than the right bundle branch (RBB): faster depolarization and repolarization.
  - **Neighboring structures:** very close to the following structures: Noncoronary and right coronary aortic valves, aortic ring (the reason why is frequent in aortic valve disease), membranous septum, subaortic septal endocardium, apex of muscular septum, right bundle branch.
  - **Irrigation:** assured by two arterial systems:
    - 1) Branches of the posterior descending artery (90% of the right coronary branch):
      - ✓ AV node artery: ramus septi fibrosi.
      - ✓ Ramus septi ventriculorum superior.
      - ✓ Ramus cristae.
    - 2) Branches of left anterior descending artery:
      - ✓ Ramus limbi sinistri (equivalent to ramus limbi dextri of the left anterior descending coronary artery).

From the beginning of last century (1906), Tawara showed the left His system as trifascicular (Tawara 1906)





Classical outline by Sunao Tawara (1906) that proves the trifascicular nature of the left His System.(Tawara S. Das Reizleitungssystem des Säugetierherzens. Eine Anatomisch-Histologische Studie Über das Atrioventrikularbün- del und die Purkinjeschen Fäden. Jena, Gustav Fischer. Published online 1906.)



Sunao Tawara studied at the Imperial University in Tokyo, graduating there in 1901, Igaku Hakushi 1908. The years 1903 to 1906 he spent in Marburg studying pathology and pathological anatomy with Karl Albert Ludwig Aschoff (1866-1942). It was here he undertook his important works on the anatomy and pathology of the heart. When returning to Japan he was appointed extraordinary professor of pathology in Fukuoka, becoming *ordinarius* of this specialty in 1908.



The Left Posterior Oblique (LPO) view shows the trans illuminated membranous septum located inferior to the interleaflet triangle between the right (R) and noncoronary (N) sinus of the aortic valve. Note that we have highlighted in dark color the limits of the endocardial position of the left bundle branch (LBB) of His and its 3 fascicles, the left anterior fascicle (1), the left septal or middle fascicle (2), and the left posterior fascicle (3). LPO ¼ left posterior oblique

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The fascicular arrangement of the left bundle branch resolved by micro-CT.

This figure demonstrates high resolution  $(73 \times 73 \times 73 \ \mu m^3)$  micro-CT data from a whole human heart.

A comparison between the visual anatomy in a macro photograph and the segmented atrioventricular conduction axis and left sided bundle branches of the heart is shown in this panel

Robert S Stephenson 1 2, Andrew Atkinson 3, Petros Kottas 4, Filip Perde 5, Fatemeh Jafarzadeh 3, Mike Bateman 6, Paul A Iaizzo 6, Jichao Zhao 7, Henggui Zhang 4, Robert H Anderson 8, Jonathan C Jarvis 9, Halina Dobrzynski 10 High resolution 3-Dimensional imaging of the human cardiac conduction system from microanatomy to mathematical modeling. Sci Rep . 2017 Aug 3;7(1):7188. doi: 10.1038/s41598-017-07694-8. Free article



Left septal fascicle

Myocardial dissection: Dr de Alemeida courtesy San Valentim Position