PROMINENT QRS ANTERIOR FORCES IN OLD MEN

Two case of Dr. Samuel Sclarovsky from Israel

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The normal QRS axis in the frontal plane is about +60º (range -30º to +105º). (1) The mean QRS axis tends to shift leftward with increasing age. This is particularly prevalent in overweigh subjects and is more pronounced in older obese men than in older obese women.

Absence of q waves on left precordial leads

"r" wave jump from V₁ to V₂

R wave of V₂ > 15 mm (R=30mm)

PROMINENT ANTERIOR QRS FORCES (PAF)
PROMINENT ANTERIOR FORCES DEFINITION BY ELECTROCARDIOGRAPHIC PARAMETERS

We consider there is presence of prominent anterior forces (PAF) in ECG, when the voltage of R wave in any precordial lead of the anterior or anteroseptal wall from V1 (+115°) through V4 (+47°) is greater than the normal maximal limit for gender and age. Electro-vectocardiographic criteria of PAF should be age-related and gender-related.

We think that the criterion used by some authors to consider the presence of PAF regards the R/S ratio in V1 is not appropriate because V2 to V4 are not considered. Thus, an R/S ratio in V1 ≥1 is considered abnormal in adults. Tall lead V1 (tall R V1) is defined as an R/S ratio equal to or greater than 1.(1) From our point of view, this criterion with these values cannot be considered as valid, since in 1% of normal individuals this ratio (R/S ratio in V1 ≥1) is found as a normal variant. In lead V2, approximately in 25% of men and 12% of women the R/S ratio is 1.

PROMINENT ANTERIOR FORCES DEFINITION BY VECTOCARDIOGRAPHIC PARAMETERS

We consider vectocardiographically that there is PAF when the vector of the 42 ms moment of the QRS loop of the HP, is located in the anterior quadrants, or when ≥50% of the area of the QRS loop is in the anterior quadrants (to the front of the orthogonal X lead) (0° to ±180°). See figure 28. The maximal spatial QRS vector magnitude, as well as the maximal QRS and T vector magnitudes in the FP, HP, and right sagital plane (RSP), are observed to decrease significantly with advancing age in both sexes and are significantly larger in men in all age groups. There are significant age- and sex-dependent differences in normal VCG parameters. These are of potential significance for diagnostic applications.(2;3)

**Prominent Anterior Forces**  DEFINITION: When the voltage of R wave in any precordial lead of the anterior or anteroseptal wall from V1 (+115°) through V4 (+47°) is greater than the normal maximal limit for gender and age. Electro-vectocardiographic criteria of PAF should be age-related and gender-related.
Another vectocardiographic parameters used sometimes to determine PAF is the Half-Area Vector: HAV
The HAV vector is the one that starts on point 0, and splits the area of the QRS loop into two equal parts.

We consider the presence of PAF when HAV is located anteriorly to +10°. In normal conditions, HAV is located in the left posterior quadrant, around -20°; however, it may be in the left anterior quadrant in normal individuals too.
ADULTS NORMAL CHARACTERISTIC OF QRS LOOP AND T LOOPS IN HP

Usually, it is oval or elliptical in shape;
QRS loop duration between 80 ms and 100 ms;
QRS loop almost always inscribed in a CCW rotation in the HP;
The initial 10 to 20 ms vector of the QRS loop represents the left 1/3 septal activation, is inscribed slowly, and is always heading anteriorly and usually (85% of cases) rightward (mean 120° range +60° to 156°);
Vector from 20 to 40 ms: represents the depolarization of paraseptal regions. It is part of the centrifugal or efferent limb of QRS loop. It is heading to the front and leftward;
Intermediary vectors, between 40 and 60 ms. They represent depolarization of free walls of both ventricles. In normal conditions, the 40 ms moment has a posterior location (behind the orthogonal X lead (0° to ±180°)); however, in young people, pregnant women and in individuals with counterclockwise rotation or levorotation of the heart on the longitudinal axis until the 44 ms moment, normally it may be anteriorly located. Some authors accept the 50 ms moment as the normal limit of the passage to the left posterior quadrant. In this paper, we consider it vectocardiographically as PAF, when the 42 ms vector is in the anterior quadrants;
The main body of the QRS loop is directed predominantly leftward and slightly posteriorly. Nonetheless, 20% of normal people have more than 70% or 2/3 of the QRS loop area in the HP of VCG, located in the left anterior quadrant. In these cases, the heart has a counterclockwise rotation on its longitudinal axis (levorotation), originating PAF. We consider there is PAF when ≥50% of the area of the QRS loop in the HP of VCG is located in the anterior quadrants (to the front of the orthogonal X lead (0° ±180°));
R loop, body of QRS loop. It stretches from the 20 ms moment up to 60 ms, and is constituted by an efferent or centrifugal limb (from 20 ms to 40 ms) and another afferent or centripetal limb (from 40 ms to 60 ms);
The middle vector of QRS is in the left posterior quadrant. In average in -15° (between 0° and -30°);
The major axis of the QRS loop is approximately twice the minor axis;
Maximal QRS vector with mean magnitude 1.2 mV and range of 0.70 to 1.90 mV or 2.2 mV;
The terminal portion of the QRS loop (last 25 ms) represents late activations of the posterobasal region of the LV, the base of the IVS and right basal ventricle: RVOT (crista). This terminal 25 ms portion is inscribed slowly and is directed posteriorly, either slightly rightward or leftward (mean direction +100° with a range from -140° to -70°);
If the terminal portion of QRS loop (S loop) or terminal appendix is located on the right posterior quadrant, it should not exceed a 20% of the total area. If the area located to the right exceeds 20%, we could be before: RVH of the VCG type, LPFB, Right End Conduction Delay (RECD), CRBBB or lateral MI. The terminal portion of the QRS loop stretches from 60 to 90 ms or 100 ms, and is located behind and to the left, or to the right of the orthogonal Z lead (+90° to -90°); ending in the J point (usually coinciding with the initial point 0, however not in all cases, even if they are normal). In the S loop there may be –as normal variant- RECD, which should not exceed 30 ms. If this occurs, it is considered there is dromotropic disorder in the RBB divisions, which in most cases corresponds to the normal variant.
The T loop usually is elliptical in shape, and frequently inscribed in a CCW rotation. Rarely, it is linear with CW rotation;
The maximal T loop vector is oriented to the left and anteriorly with a mean value of +25° (range -15° to +45°);
The magnitude of the maximum T loop is 0.34 mV (range 0.15 to 0.60 mV);
The QRS/T angle should not exceed +75°
Possible causes of Prominent Anterior electromotive QRS Forces

1. Normal variant(1)
2. Athlete Hear: highly-trained athletes Pseudo right ventricular enlargement(2)
3. Electrocardiographic artifacts due to electrode misplacement: abnormal R progression in the precordial leads(1).
4. Posterior and posterolateral myocardial infarction(1)
5. Right ventricular hypertrophy types A and B vectorcardiographic

**6. Left ventricular hypertrophy:** Dislocation of transition zone to the right (the site of the lead in which the amplitudes of the positive and negative deflections are of equal magnitude) by counterclockwise rotation of the heart in its longitudinal axis. The left ventricle faces the intermediary leads V3 and V4 and no longer V5 and V6. For this reason, prominent anterior forces may occur.

7. Hypertrophic cardiomyopathy and some forms of cardiomyopathy *So much in its obstructive form as not obstructive particularly the Japanese apical variant* and some forms of other cardiomyopathies.

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7. Cardiomyopathy of Duchenne muscular dystrophy (DMD) Progressive muscular dystrophy (1)
8. Type A Wolff-Parkinson-White syndrome(3) The left-sided accessory pathways may give rise to prominent R-waves in right precordial leads simulating right ventricular hypertrophy(2).
9. Right Bundle Branch Block: anterior displacement of the QRS loop as a right ventricular conduction disturbance(5)
10. Anatomical dextroposition of the heart (it is necessary to differentiate carefully with dextrocardia and dextroversion)
11. Endomyocardial fibrosis
12. Left Septal Fascicular Block(7) aberrant conduction anterior displacement of QRS

Isolated LSFB has QRS duration < 120 ms, in general, close to 100 ms. The appearance of LFB does not increase QRS duration by more than 25 ms, due to multiple interconnections between the fascicles of the Left Bundle Branch ("passage way zone" of Rosenbaum). The QRS complex is slightly prolonged between 100 ms to 115 ms. Thus, LSFB pattern with a prolonged QRS duration indicates the presence of additional conduction disturbances such as: other fascicular blocks, RBBB, myocardial infarction, focal block, or a combination of these.

Like left posterior fascicular Block (LPFB) isolated LSFB is rarely identified as an isolated finding except when paroxysmal. Most of case are associated with left anterior fascicular block (LAFB), right bundle branch block or LPFB.

It is uncertain whether this represent normal variant or LSFB.(1)

LSFB is characterized by R wave voltage "in crescendo" from V₁ to V₃ and decreasing from V₄, V₅ to V₆.

"r" wave jump from V₁ to V₂

Absence of q wave in V₅, V₆

Because absence of First middle septal vector
Why the absence of initial q wave in left leads I, aVL, V₅ and V₆? Answer: because the absence of the initial middle septal vector of 10 to 20ms or vector $1_{AM}$ corresponding to the initial activation of the middle third of the left septal surface usually directed to front and from left to rightward. It is necessary absence of Incomplete LBBB, complete LBBB or WPW.
Since the work by Durrer et al (1), it is known that the initial ventricular activation takes place in the three points corresponding to the site where the three left ventricular fascicles end. As the resulting vectors of the activation of the regions depending on the left anterior fascicle (LAF) and the left posterior fascicle (LPF), they have opposite directions, and they annul each other.

Thus, the only vector that manifests is the one dependent on the left septal fascicle (LSF), which originates the septal vector, vector 1, Peñaloza / Tranchesi vector(2) or \( 1_{AM} \) vector, which corresponds to the activation of the middle third of the left septal surface, usually heading to the front and the right, thus originating the initial r wave of \( V_1 \) and \( V_2 \) and the q waves of the left leads \( V_5-V_6 \).

Representation of vectors \( 1_{AM} \) and \( 1_d \).

SEQUENCE OF NORMAL INITIAL VENTRICULAR ACTIVATION

1) CENTRAL & APICAL REGION
2) ANTERO-SUPERIOR REGION
3) POSTERO-INFERIOR REGION

Initial
0 ms to 10 ms

Time sequence of ventricular cone activation, which shows the initial activation in three points.

ORIGIN OF INITIAL VECTORS OF VENTRICULAR ACTIVATION

Representation of the first vectors dependent on the left bundle branch (LBB) and the right bundle branch (RBB)

1) **Left Anterior Fascicle**: it originates the $1_{as}$ vector.
2) **Left Posterior Fascicle**: it originates the $1_{pi}$ vector.
3) **Left Septal Fascicle**: it originates the $1_{am}$ vector.
4) **RBB**: Right Bundle Branch of the His bundle: it originates the $1_{d}$ vector minimally latter.

**LBB**: Left Bundle Branch.

Since the activation vectors dependent on the anterosuperior (1) & posteroinferior (2) fascicles, go in opposite directions, they annul each other. This is the reason why the only vector that manifests is the one dependent on the Left Septal Fascicle (LSF). $1_{am}$
Hypothetical Ventricular Activation Sequential In Isolated Left Septal Fascicular Block

In case of isolated LSFB, the sequence of ventricular activation begins in two points:
The base of the anterolateral papillary muscle (ALPM) of mitral valve dependent on left anterior fascicle (LAF) in the anterior paraseptal wall, just below the attachment of ALPM ($1_{\text{AM}}$ vector)
The base of the Posteromedial Papillary Muscle (PMPM) of mitral valve dependent on Left Posterior Fascicle (LPF). It is located on the posterior paraseptal wall, about one third of the distance from apex to base ($1_{\text{PI}}$ vector).
These initial two vectors have opposite directions, and they annul each other with minimal predominance of vector $1_{\text{PI}}$ directed backward. (initial q waves in $V_2-V_3$) Next, the stimulus is heading to the middle-septal or left paraseptal region, blocked by numerous Purkinje areas of passage, thus shifting the forces to the front and the left: Prominent Anterior Forces (PAF).
OUTLINE OF THE NORMAL ACTIVATION SEQUENCE OF THE BIVENTRICULAR CHAMBER

Sequence in milliseconds of ventricular activation.
Absence of initial q wave in left leads V5 and V6 is indicative of LSFB.

"r" wave jump from V1 to V2

R/s ratio in V2 > 2
QRS axis -30° It is the normal limit of SÂQRS in frontal plane. The normal QRS axis in the frontal plane is about +60° (range -30° to +105°).(1) The mean QRS axis tends to shift leftward with increasing age. This patient has 95 years old of age and he has high blood pressure.
Absence of q waves on left precordial leads

Because the absence of first middle septal vector or $1_{AM}$ vector.
The activation vectors dependent on the anterosuperior (1) & posteroinferior (2) fascicles, go in opposite directions, they annul each other with frequent predominance of $1_{PI}$ vector related $1_{AM}$. 
The Brazilian Guidelines for Interpreting Rest Electrocardiogram (1) provided us with the following criteria for ECG diagnosis of LSFB:

QRS duration < 120 ms, in general, close to 100 ms. The appearance of LFB does not increase QRSD by more than 25 ms, due to multiple interconnections between the fascicles of the LBB ("passage way zone" of Rosenbaum). The QRS complex is slightly prolonged between 100 ms to 115 ms. Thus, LSFB pattern with a prolonged QRSD indicates the presence of additional conduction disturbances such as: other fascicular blocks, RBBB, MI, focal block, or a combination of these;

R waves voltage ≥ 15 mm in V2 and V3 or from V1;
Increasing voltage for all intermediary precordial leads and decreasing from V5 to V6;
"r" wave jump may occur from V1 to V2 ("rS" in V1 for R in V2);
Absence of SAQRS shift or not more than -30º;
Absence of q wave on left precordial leads.

Observation: all these criteria are valid in absence of RVH, septal hypertrophy or dorsal MI and other causes of PAF.