Bioengineering 6460

Clinical EP Studies

Ravi Ranjan
Division of Cardiology
ravi.ranjan@hsc.utah.edu
Basics of ECG

Normal Sinus Rhythm

Normal duration of PR interval is 0.12-0.20 s (three to five small squares)
Propagation in Normal Rhythm
Normal ECG

Vent. rate: 62 BPM
PR interval: 154 ms
QRS duration: 92 ms
QT/QTc: 402/408 ms
P-R-T axes: 36 38 40

Referred by: MOHAMED HAMDAN
Confirmed By: Ravi Ranjan

Technician: AMBER
Test ind: 780.2
Bundle Branch Block
Sinus bradycardia
Right bundle branch block
Abnormal ECG
When compared with ECG of 30-SEP-2011 09:46,
No significant change was found

25mm/s 10mm/mV 150Hz 7.1.1 12SL 235 CID: 49
EID:3216 EDT: 16:10 27-OCT-2011 ORDER: ACCOUNT: 186843227

Technician: TSS
Test nd:786.50

COMMENT:186843227

Referred by: BRENT WILSON
Confirmed By: Ravi Ranjan

Ventricular rate 53 BPM
PR interval 174 ms
QRS duration 138 ms
QT/QTc 458/429 ms
P-R-T axes 76 78 46

GODFREY, JEFFREY
ID:011951696
25-OCT-2011 08:12:43
UNIVERSITY HEALTH CARE

17-JAN-1952 (59 yr)
Male
Caucasian
75in
182lb
Room:06
Loc:4
Option:0

Technician: TSS
Test nd:786.50

COMMENT:186843227

Referred by: BRENT WILSON
Confirmed By: Ravi Ranjan

Ventricular rate 53 BPM
PR interval 174 ms
QRS duration 138 ms
QT/QTc 458/429 ms
P-R-T axes 76 78 46

GODFREY, JEFFREY
ID:011951696
25-OCT-2011 08:12:43
UNIVERSITY HEALTH CARE
Sinus rhythm with 1st degree A-V block
Left axis deviation
Left bundle branch block
Abnormal ECG
No previous ECGs available

Vent. rate 64 BPM
PR interval 234 ms
QRS duration 184 ms
QT/QTc 516/532 ms
P-R-T axes -23 -57 117

Technician: TSS
Test ind: VT
Comment: 185310459

Study:

Referred by: HAMDAN
Confirmed by: Ravi Ranjan

EID: 3216 EDT: 16:43 27-OCT-2011 ORDER:
Sinus Bradycardia

Marked sinus bradycardia
Abnormal ECG
When compared with ECG of 25-OCT-2011 11:39,
No significant change was found

25mm/s 10mm/mV 150Hz 7.1.1 12SL 239 CID: 70
Sinus Tachycardia

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Referred by: NATALIE SANDERS
Confirmed By: Ravi Ranjan

Technician: AMBER
Test Ind:780.2

Sinus tachycardia
Otherwise normal ECG
When compared with ECG of 29-APR-2010 19:34,
No significant change was found

 комнат: 09-MAY-1956 (55 yr)
Sex: Male
Race: Caucasian

Room: Loc:126

Referred by: NOLAN SANDERS
 ID:013674221
13-OCT-2011  10:39:57

Vent. rate 104 BPM
PR interval 132 ms
QRS duration 86 ms
QT/QTc 326/428 ms
P-R-T axes 80 75 72

BPM 104
Vent. rate 132
PR interval 86
QRS duration 326
QT/QTc 428
P-R-T axes 80

25mm/s 10mm/mV 150Hz 7.1.1 12SL 239 CID: 51
Atrial Flutter

ID:003932084
UNIVERSITY HEALTH CARE

Vent. rate 113 BPM
PR interval 98 ms
QRS duration 98 ms
QT/QTc 324/444 ms
P-R-T axes 84 81 76

Technician: FJ
Test ind: SVT

Referred by: Mohamed HAMDAN
Confirmed by: Ravi Ranjan

COMMENT: 187092558
Atrial Fibrillation

ID:010127587  UNIVERSITY HEALTH CARE

ID:010127587

ODONNELL, RAENELL

ID:010127587

25-OCT-2011  15:06:10

UNIVERSITY HEALTH CARE

Atrial fibrillation

Abnormal ECG

When compared with ECG of 16-AUG-2011 14:09,

No significant change was found

ODONNELL, RAENELL

ID:010127587

25-OCT-2011  15:06:10

UNIVERSITY HEALTH CARE

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When compared with ECG of 16-AUG-2011 14:09,

No significant change was found

ODONNELL, RAENELL

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ODONNELL, RAENELL

ID:010127587

25-OCT-2011  15:06:10

UNIVERSITY HEALTH CARE

Atrial fibrillation

Abnormal ECG

When compared with ECG of 16-AUG-2011 14:09,
Ventricular Tachycardia
Ventricular Tachycardia
Ventricular Tachycardia
Supra Ventricular Tachycardia
Basic EP recordings

HRA = high right atrium; His = His bundle; DCS, PCS = distal and proximal coronary sinus; RVA = right ventricular apex.

Figure 1.3b-i illustrates the standard catheter positions for a ‘four-wire’ diagnostic EP study.
Basic EP recordings

1.3b-i

HRA = high right atrium; His = His bundle; DCS, PCS = distal and proximal coronary sinus; RVA = right ventricular apex.

Figure 1.3b-i illustrates the standard catheter positions for a "four-wire" diagnostic EP study.

1.3b-ii

Figure 1.3b-ii shows the catheter positions for a standard "four-wire" diagnostic EP study in the posteroanterior (top) and left anterior oblique (bottom) fluoroscopic projections. Abbreviations as in Figure 1.3b-i.
Basic EP recordings

Electrograms displayed during standard four-wire study in sinus rhythm. Although all twelve surface ECG leads are recorded, only three approximately orthogonal leads are shown, for clarity. The right ventricular apex (RV) and high right atrium (HRA) leads show sharp single chamber electrograms. The His bundle catheter records activity adjacent to the AV node; the distal bipolar (HBE D) favors the His bundle electrogram (H) and the adjacent ventricular myocardium (V), while the proximal bipolar (HBE P) shows a large atrial electrogram (A). Note that, although the ventricular spike recorded by the His bundle comes from tissue adjacent to the bundle of His, the earliest ventricular activity is at the apex (RV). The electrograms recorded by the bipolar of the decapolar coronary sinus catheter are labeled CS 9–10 (proximal) to CS 1–2 (distal); each shows a sharp atrial electrogram followed by a smaller ventricular electrogram.
WPW

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Technician: TSS
Test ind: 426.7

Comment: 186170738
Study:

Referred by: Roger FREEDMAN
Confirmed By: Mohamed HAM DAN

Vent. rate 56 BPM
PR interval 80 ms
QRS duration 164 ms
QT/QTc 470/453 ms
P-R-T axes 106 41 45
WPW
Supra Ventricular Tachycardia (SVT)

- AVNRT – AV nodal re-entrant tachycardia
- AVRT – Atrio-ventricular re-entrant tachycardia
- AT – atrial tachycardia
SVT initiation

AVNRT
AV nodal re-entrant tachycardia

ORT
Orthodromic re-entrant tachycardia

AT
Atrial Tachycardia
Dual Node Pathway
AVNRT
Dual Node Pathway

Tracing 4.1a Following an atrial drive train (S1S1 = 600 ms), an atrial extrasinus is given (S1S2 = 360 ms). The AH interval of the extrasinus (A2H2) is greater than that of the drive train (A1H1) because of decrement in the AV node.
Tracing 6.1a The onset of tachycardia may differ according to the tachycardia mechanism. AV nodal reentry is induced by an atrial extrastimulus, which results in block in the fast pathway and conduction over the slow pathway. The AH prolongation is obvious but the mechanism can also be seen in the surface leads.
AVRT – initiation
Orthodromic Re-entrant Tachycardia (ORT)
Orthodromic AVRT is induced by an atrial extrastimulus. The key element of induction of tachycardia is block in the accessory pathway with loss of pre-excitation (*), allowing retrograde conduction up the accessory pathway to the atrium, thereby completing the circuit (see Section 5.4).
In this example, the onset of atrial tachycardia is accompanied by a trivial increase in the AH interval, related to the increased atrial rate. However, subtle changes occur in the P-wave morphology between sinus rhythm (P) and tachycardia (P'), which correspond to slight changes in the atrial activation sequence seen on the intracardiac recordings. The observed AH interval makes AV reentry and AV node reentry very unlikely, since these are almost always associated with obvious AH prolongation.
Tracing 5.6 Pacing from the right ventricular apex (left panel) demonstrates earliest activation at the proximal CS with a stimulus-to-atrial interval of 140 ms. After the catheter is positioned at the RV base (right panel; Figure 5.6c), the stimulus-to-atrial interval shortens to 100 ms, which is consistent with the diagnosis of a right posterior accessory pathway.
Location of Accessory Pathway
Retrograde Atrial Activation
Concentric vs Eccentric
Retrograde Atrial Activation

Tracing 5.2a A patient with a left free wall accessory pathway. During the ventricular drive train (S1), the atria are activated retrogradely by the His-Purkinje system and the AV node. The earliest atrial signal (A*) is recorded by the His catheter — indicating concentric atrial activation. A ventricular extrastimulus (S2) with a coupling interval of 380 ms is delayed in the AV node, allowing the impulse to travel up the pathway to the atria. Atrial activation (A2) is now eccentric, with the earliest signal (A) recorded by the distal coronary sinus catheter.
Effect of BBB in SVT
With LBBB the VA time increases.

**Tracing 6.5b** AVRT with a left lateral accessory pathway. The first four beats show LBBB and the VA interval is 120 ms. Following a PVC (S), LBBB disappears and the VA interval shortens to 100 ms, with consequent shortening in the tachycardia cycle length. It is thus demonstrated that the left bundle branch participates in the circuit. Increase in tachycardia cycle length with bundle branch block is proof that the bundle, and by inference an ipsilateral accessory pathway, is part of the circuit.

Note that the ventricular signals in the coronary sinus electrogram give a misleading impression of the VA interval. During LBBB, these signals arrive late compared to global ventricular activation, so, although the true VA interval is long, the local VA is short. The converse occurs when LBBB ceases. This illustrates the importance of measuring the VA interval from the very earliest ventricular activation (here, as is usual, the beginning of the surface QRS complex).
Left sided pathway and RBBB
Left sided pathway and RBBB
No change in VA

Tracing 6.5c AVRT with a left lateral accessory pathway. In the left half of the tracing, there is RBBB (most obvious in lead V1), which resolves with delivery of a single ventricular extrastimulus. This has no effect on the VA interval (and consequently none on the tachycardia cycle length), indicating that the right bundle branch (RBB) is not part of the circuit.
PVC on His
PVC on His

Tracing 6.18: A VPD with a right accessory pathway. A single ventricular extrasystole (SD) is delivered just prior to the 1st deflection without affecting its timing. The result is advancement of the subsequent atrial electrogram by 30 ms, as measured in the high right atrium. An accessory pathway must therefore be present. Note that the ventricular pacing cycle length is very stable prior to the PVC. If there were significant "wobble", it would be difficult to be certain that the advanced atrial electrogram was indeed due to the PVC. The early atrial activation results in an increased RP interval. As a result the whole circuit is only marginally enhanced.
Parahisian Pacing

No AP

With AP
Tracing 5.7 On beats two and three there is His capture: the surface QRS complex is narrow and the RV apex is activated early. On beats one and four there is loss of His capture: the surface QRS complex is wide and the time from stimulus to RV apex activation is long. There is very little prolongation of the VA interval with loss of His capture. This indicates that retrograde conduction is not solely over the node, and that an accessory pathway close to the anteroseptal region is probably present. In this example, the earliest activation is in the proximal CS throughout, and the accessory pathway was isolated in the midseptal region. In the absence of an accessory pathway, loss of His capture would be accompanied by prolongation of the VA interval by at least 50 ms.