Role of P Wave Indices in Normal Sinus Rhythm and Tachycardia

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Keywords

▪ Atrial Fibrillation
▪ Electrocardiogram
▪ P wave axis
▪ P wave dispersion
▪ P wave indices
▪ Sinus rhythm
▪ Sinus tachycardia
Objectives

- To illustrate the extended implications drawn from P Wave Indices (PWI) for determination of tachycardia.

- To study the PWI such as P wave axis, amplitude, duration, dispersion, PP Interval (PPI) and PR Interval in Sinus Rhythm (SR) and Sinus Tachycardia (ST).
Methods

- ECGs were recorded from 50 SR (mean ± SD; 35 ± 18.42) and 25 ST (19 ± 3.93) volunteers.
- EDAN PC-1010 machine was used to record ECG for limb leads at the standard paper speed.
- All the values are given in mean ± SD. Kolmogorov Smirnov test, Pearson’s correlation, 2 tailed Student’s T-test were performed. P < 0.05 (level of significance).
Results
Fig. 1. P wave features in sinus rhythm single beat ECG.  

Fig. 2. P wave amplitudes for each lead in SR and ST groups.
## TABLE I. P WAVE AMPLITUDE AND AXIS IN SR AND ST GROUPS

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Limb Leads</th>
<th>SR (n = 50)</th>
<th>ST (n = 25)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Min; Max</td>
</tr>
<tr>
<td>P wave amplitude (µV)</td>
<td>I</td>
<td>60</td>
<td>20.64</td>
<td>23; 125</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>89</td>
<td>34.16</td>
<td>17;161</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>52</td>
<td>29.24</td>
<td>15;133</td>
</tr>
<tr>
<td></td>
<td>aVR</td>
<td>71</td>
<td>20.61</td>
<td>32;142</td>
</tr>
<tr>
<td></td>
<td>aVL</td>
<td>36</td>
<td>13.46</td>
<td>17;82</td>
</tr>
<tr>
<td></td>
<td>aVF</td>
<td>66</td>
<td>31.46</td>
<td>15;133</td>
</tr>
<tr>
<td>P wave axis (°)</td>
<td>-</td>
<td>49</td>
<td>17.90</td>
<td>5;90</td>
</tr>
</tbody>
</table>
**Fig. 3.** Relationship of heart rate with P wave amplitude in (A) SR (n = 50) and (B) ST (n = 25).

**Fig. 4.** Relationship of P wave axis with P wave amplitude in (A) SR (n = 50) and (B) ST (n = 25).
TABLE II. HEART RATE AND P WAVE FEATURES IN SR AND ST VOLUNTEERS

<table>
<thead>
<tr>
<th>Measurements</th>
<th>SR (n=50)</th>
<th></th>
<th>ST (n=25)</th>
<th></th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Min; Max</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>78</td>
<td>7.53</td>
<td>62; 90</td>
<td>109</td>
<td>4.84</td>
</tr>
<tr>
<td>PP interval (ms)</td>
<td>778</td>
<td>78.91</td>
<td>667; 968</td>
<td>550</td>
<td>24.08</td>
</tr>
<tr>
<td>P wave duration (ms)</td>
<td>96</td>
<td>9.18</td>
<td>72; 116</td>
<td>96</td>
<td>10.01</td>
</tr>
<tr>
<td>P wave dispersion (ms)</td>
<td>20</td>
<td>11.32</td>
<td>2; 48</td>
<td>13</td>
<td>10.01</td>
</tr>
<tr>
<td>PR interval (ms)</td>
<td>138</td>
<td>17.60</td>
<td>107; 181</td>
<td>135</td>
<td>18.25</td>
</tr>
</tbody>
</table>
Fig. 5. Correlation of heart rate with P wave duration (A, B), P wave dispersion (C, D) PR Interval (E, F) in SR and ST groups.
Discussion
▪ **Higher P wave amplitude** in ST volunteers than SR were noted which indicates that increase in heart rate, significantly increase the P wave amplitude [5]. It is also noted that, mean **P wave axis** is higher in ST than SR.

▪ **Higher variability of P amplitude is noted in SR** compared to ST. It can be reasoned by the study [6] that healthy heart is more dynamic leading to higher heart rate variability compared to diseased heart.

▪ P wave Dispersion (PD) for ST is lesser than the SR and both the values are within the 40 ms with outliers below 48 ms for both the groups. It is noted from the previous studies that, **PD value increases significantly in atrial tachycardia** condition [7].

▪ However in this study, the ST volunteers have **lesser PD may be due to the effect of physiological changes.**
Conclusion

- **Higher heart rate** may lead to an increase in P wave axis, making atrial depolarization electric mean vector more parallel to lead II; thus, increasing the amplitude values.

- Heart rate and PPI are **inversely correlated** with $r = -0.9$.

- **Healthy heart is more dynamic** compared to during any physiological and pathological conditions.

- More elaborate studies on PD variations in sinus tachycardia can provide the better understanding of heart activity in response to physiological conditions.
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References


Thank You