The differences between two algorithms used to measure ECG subintervals in intervention-free, fasted volunteers taking part in an intensive QT study

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Introduction

A variety of algorithms are used to automatically measure ECG subintervals as part of intensive QT studies. Different algorithms have been observed to generate different subinterval values. Differences between algorithms are clinically small, but still statistically significant [1].

Differences between algorithms when measuring QT interval duration are larger in those subjects displaying long QT than in subjects with QT intervals within the normal range [1].

Discrepancies between different algorithms have been observed to be due to a lack of standard definition for the location of the T-wave peak when this wave has an abnormal morphology [2].

Methods

Study design: The retrospective analysis reported here was based on data from an already published TQT study (NCT number: NCT01642485). The original study investigated the impact of a meal on ECG subintervals. The study cohort consisted of healthy, non-smoking Japanese and Caucasian volunteers (18 males and 14 females) participating in a single centre, randomised, placebo- and positive-controlled cross-over study aiming to evaluate the effects of different meal compositions on the QTc interval.

ECG Analysis: ECGs were recorded in triplicate and processed using the GE Healthcare Marquette 12SL ECG analysis program and either the GE research QT GuardPlus algorithm or the Analyzing Medical Parameters for Solutions (AMPS) BRAVO algorithm.

F tests were performed in order to analyse variance in the data generated by each algorithm. Passing-Bablok and Bland-Altman analysis were performed to determine the biases of the data generated by each algorithm. Statistical analyses were executed and visualised using R and SAS.

Conclusions

The data from this study indicate that there is significant, quantifiable variation between the two algorithms.

For QT studies, the change from baseline QT is more important than the absolute values, therefore care should be taken that directly compared ECG subinterval data have used the same algorithm.

QT/QTcF are longer in QT Guard because this algorithm produces significantly longer $T_{peak}T_{end}$ estimates. Equal variances and lack of any proportional bias in the data support the observation that differences between algorithms are mostly due to disagreements in how the T peak is determined and processed.

Uncorrected and corrected data both have constant bias and no proportional bias.

Sex differences in subinterval length are observed to be different, but the directions of trends are maintained.

This study is limited in that it does not examine the effect of a QT prolonging drug, and it only looks at healthy patients. This is important because T wave morphology has been implicated in differences between algorithms, and QT prolonging drugs and cardiac pathology can alter T morphology [3].

Acknowledgements

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References

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Results

Table 1. Mean subinterval durations reported by each algorithm.

	Overall		Male		Female	
	QT Guard	Bravo	QT Guard	Bravo	QT Guard	Bravo
HR	54.97 (±6.67)	54.94 (±6.67)	55.26 (±6.82)	55.24 (±6.79)	54.60 (±6.54)	54.55 (±6.57)
RR	1107.67 (±135.99)	1108.07 (±135.15)	1102.02 (±136.07)	1101.91 (±135.34)	1114.93 (±137.18)	1116.00 (±136.12)
QT	428.60 (±26.97)	418.27 (±27.58)	421.74 (±28.13)	410.52 (±28.38)	437.43 (±22.81)	428.24 (±23.25)
QTcF	414.46 (±17.56)	404.75 (±18.69)	408.39 (±15.29)	397.81 (±15.97)	422.26 (±17.35)	413.67 (±18.31)
QRS	95.58 (±6.90)	92.04 (±6.84)	99.26 (±5.55)	94.41 (±6.42)	90.86 (±5.45)	89.00 (±6.20)
J-T	224.98 (±25.44)	237.35 (±25.65)	211.44 (±19.32)	225.33 (±21.55)	242.38 (±21.56)	252.81 (±22.11)
J-TcJ	212.38 (±18.61)	223.97 (±17.43)	200.17 (±10.61)	213.28 (±11.08)	228.07 (±14.43)	237.71 (±14.20)
TpTe	107.88 (±10.88)	88.88 (±9.47)	110.74 (±12.98)	90.78 (±11.21)	104.19 (±5.65)	86.43 (±5.89)

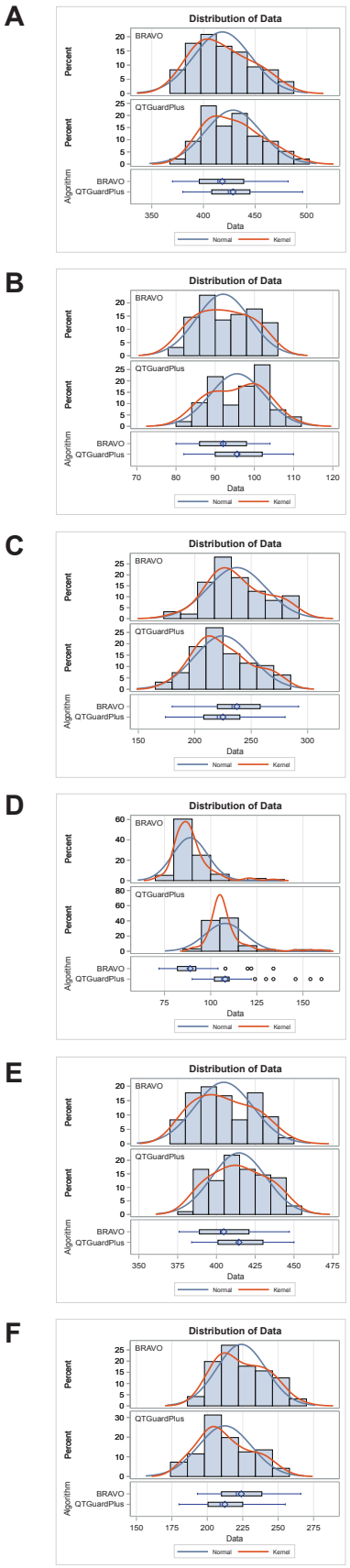

Figure 1: Distribution of interval durations in each algorithm. (A) QT; (B) QRS; (C) J-T_{peak} and (D) T_{peak}-T_{end}; (E) QTcF; (F) J-T_{peak}cJ

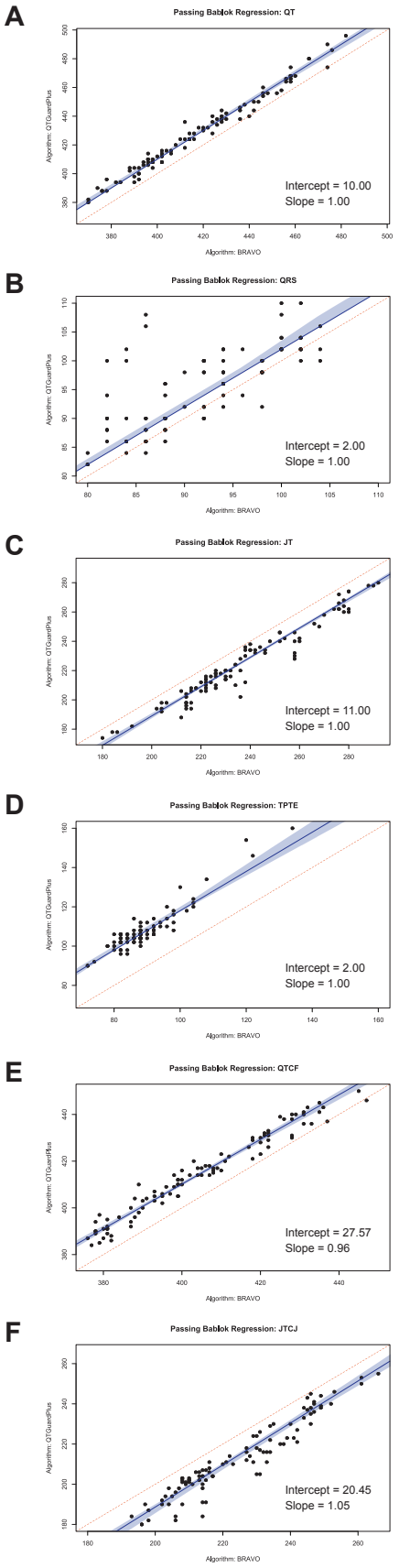

Figure 2: Passing-Bablok regression for data determined by each algorithm. (A) QT; (B) QRS; (C) J-T_{peak} and (D) T_{peak}-T_{end}; (E) QTcF; (F) J-T_{peak}cJ Red dotted line indicates intercept = 0, slope = 1.

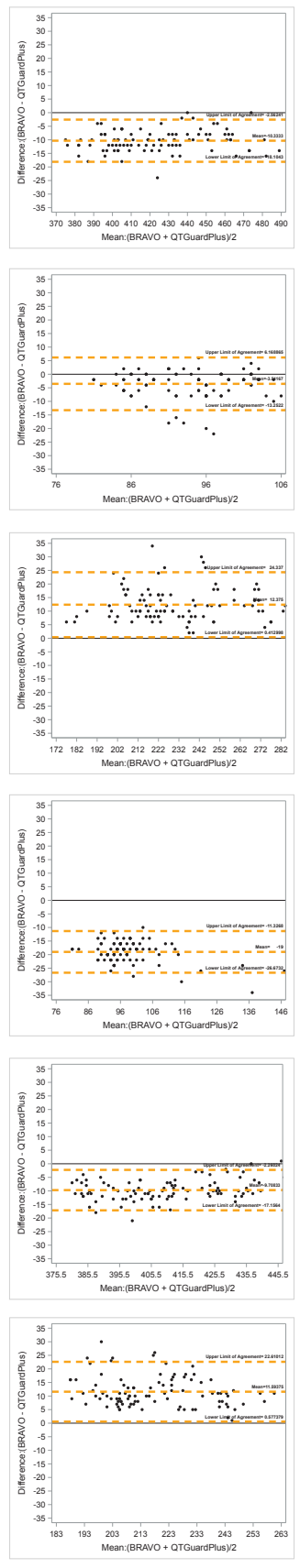

Figure 3: Bland-Altman analysis comparing means generated by each algorithm. (A) QT; (B) QRS; (C) J-T_{peak} and (D) T_{peak}-T_{end}; (E) QTcF; (F) J-T_{peak}cJ.

Table 1 data shows that QT and QTcF are always longer in QT Guard (in both males and females). This is primarily due to $T_{peak}T_{end}$ being measure longer in QT Guard (overall 19 ms). Although J-T_{peak} and J-T_{peak}cJ are conversely longer in Bravo (7 ms and 11 ms respectively) this is not enough to offset longer $T_{peak}T_{end}$ in QT Guard, resulting in a 10ms longer QT and 10 ms longer QTcF.

F tests showed that variances of subinterval durations (**Figure 1**) determined by each algorithm were not significantly different (P > 0.1) Bablok analysis was performed showing a directly proportional relationship, with slope close to 1, between the means in each algorithm (**Figure 2**). This shows that there was a constant difference in the calculation of the data, but no proportional bias. Bland-Altman analysis (**Figure 3**) confirms that bias is constant and not proportional. Note that the limits of agreement on these plots are statistical, rather than clinical.

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