# ECG variations in patients pre- and post-local anaesthesia and analgesia

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# IN BRIEF

- Demonstrates that ECG changes in clinically healthy individuals are common and some may be of clinical significance.
   The use of local anaesthetics may directly
- Analgesics may also affect cardiac
- rhythm following oral surgery.

**Objectives** To determine the incidence of ECG abnormalities in a healthy adults undergoing a surgical extraction of third molar teeth pre-and post-operatively and to study the effect of local anaesthetics, surgical stress and analgesics on cardiac rhythm. **Method** One hundred and ninety-eight healthy adult patients taking part in a clinical trial of analgesics were randomly selected for this study. All patients required the removal of at least one impacted mandibular wisdom tooth under local anaesthetic. An ECG was taken at a screening visit and repeated post-operatively 30 minutes after analgesia was given. The effects of analgesia were also monitored to ascertain whether any changes were related to pain experience or the analgesic itself. **Results** ECG abnormalities were detected in 44 patients at the screening visit. Of these patients, 20 showed rsR complex patterns, seven showed non-specific ST elevation, six patients had an abnormal P wave axis, three patients presented with single atrial premature beats and three patients showed a short PR interval. Other minor abnormalities were seen in 60 patients. Nineteen patients showed rsR complex patterns, sinus arrhythmias were seen in 11 individuals, seven patients showed non-specific ST elevation and six patients had an abnormal P-wave axis. Other minor abnormalities were occasionally seen. The results were not statistically significant, some of the patients did show clinically relevant abnormalities which necessitated referral to a cardiologist. These included: marked ST elevation; marked ST depression and one case of Right Bundle Branch Block (RBBB).

# INTRODUCTION

Electrocardiographs (ECGs) have been used to monitor the electrical activity of the heart for many years and are still routinely used in many situations. They are rarely used in routine outpatient dental practice. However, for many years it has been shown that unexpected and asymptomatic disorders of cardiac rhythm and conduction may be discovered during examination of apparently healthy individuals. Brady-arrhythmias (including sinus arrhythmia, sinus bradycardia and nocturnal A-V block) are common findings and detectable in up to 50% of a young adult population (Fig. 1).<sup>1</sup>

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Online article number E23 Refereed Paper – accepted 5 February 2009 DOI: 10.1038/sj.bdj.2009.978 ®British Dental Journal 2009; 207: E23 During the last decade, cardiovascular side effects have been discovered resulting from drugs which were introduced for non-cardiac indications. For example, local anaesthetic agents designed to alter ionic fluxes across peripheral nerve membranes may have a potent effect on cardiac electrophysiology.

The potential effect of local anaesthetic on cardiac rhythm has also been reported in the literature.<sup>2-4</sup> Moreover, the anxiety associated with both minor surgery and the injection of local anaesthetic may induce a catecholamine surge which could increase myocardial oxygen demand and may be arrhythmogenic.5,6 Thus, overly anxious patients often exhibit signs of vasodepression, pallor, tachycardia and palpitation. Systemic reactions during local anaesthesia may also be of psychological origin, as many people suffer mild anxiety about dental treatment and emotional stress is a common occurrence. The dose of local anaesthetic agent employed for most surgical procedures is not in general





associated with a cardio-depressant effect, although some cardiovascular depression may also occur following extensive use of local anaesthesia.<sup>7,8</sup>

In 1964 Hunter reported that traction of the trigeminal root during neurosurgical manoeuvring could precipitate irregularities of cardiac rhythm.<sup>9</sup> This suggests that oral surgery may be a particularly potent motivator of sympatho-adrenal response.





Table 1 ECG abnormalities on the screening visit				
Abnormalities	No. of patients			
rsR complex	20			
Non- specific ST elevation	7			
Abnormal PR interval	6			
Sinus arrhythmia	3			
Short PR interval	3			
Sign of left ventricular hypertrophy	2			
Atrial premature beat	2			
Ventricular premature beats	1			
Left ventricular hyper atrophy was defined as R plus S waves (V1, 2 and V5, V6) >35 mm				



Fig. 5 Ventricular complex labelling





AbnormalitiesNo. of patientsStudy medicationrsR complex19A,B,C&DSinus arrhythmia11A,B,C&DST segment elevation7B,C&DAbnormal P wave axis6A,B&CPremature atrials beats4D&CShort PR interval3C&DSinus bradycardia3B,C&D	Table 2 ECG abnormalities post analgesic dose					
rsR complex19A,B,C&DSinus arrhythmia11A,B,C&DST segment elevation7B,C&DAbnormal P wave axis6A,B&CPremature atrials beats4D&CShort PR interval3C&DSinus bradycardia3B,C&D	Abnormalities	No. of patients Study medicatio				
Sinus arrhythmia11A,B,C&DST segment elevation7B,C&DAbnormal P wave axis6A,B&CPremature atrials beats4D&CShort PR interval3C&DSinus bradycardia3B,C&D	rsR complex	19	A,B,C&D			
ST segment elevation7B,C&DAbnormal P wave axis6A,B&CPremature atrials beats4D&CShort PR interval3C&DSinus bradycardia3B,C&D	Sinus arrhythmia	11	A,B,C&D			
Abnormal P wave axis6A,B&CPremature atrials beats4D&CShort PR interval3C&DSinus bradycardia3B,C&D	ST segment elevation	7	B,C&D			
Premature atrials beats4D&CShort PR interval3C&DSinus bradycardia3B,C&D	Abnormal P wave axis	6	A,B&C			
Short PR interval   3   C&D     Sinus bradycardia   3   B,C&D	Premature atrials beats	4	D&C			
Sinus bradycardia 3 B,C&D	Short PR interval	3	C&D			
	Sinus bradycardia	3	B,C&D			
Sign of left ventricular hypertrophy 2 B&D	Sign of left ventricular hypertrophy	2	B&D			
Prolongation of QT intervals 2 A&D	Prolongation of QT intervals	2	A&D			
ST depression 2 C&D	ST depression	2	C&D			
Marked ST elevation (5-8 mm) 1 C	Marked ST elevation (5-8 mm)	1	С			
RBBB pattern with broad QRS 1 D	RBBB pattern with broad QRS	1	D			

Group A - placebo; Group B - Pregabalin 50 mg; Group C - Pregabalin 300 mg; Group D - Ibuprofen 400 mg

The potential effect of post-operative analgesia also needs to be considered. The ECG recordings were taken during the throughput of a clinical study using two pharmacologically dissimilar analgesics (ibuprofen/pregabalin) for post surgery analgesia. Ibuprofen is a non-steroidal anti-inflammatory agent which inhibits cyclo-oxygenase activity and, as a result, synthesis of prostaglandin and thromboxane is reduced.<sup>10</sup> Pregabalin is a 3-alkylated gamma amino-butyric acid (GABA) derivative with known analgesic properties. Its analogue Gabapentin has several uses including pain management.<sup>11,12</sup>

The purpose of this study was:

- To determine the incidence of ECG abnormalities in a healthy adults undergoing a surgical extraction of third molar teeth pre-and post-operatively
- To study the effect of local anaesthetics, surgical stress and analgesics on cardiac rhythm (Fig. 2).

# MATERIALS AND METHODS

This study examined the ECG abnormalities among healthy adults who were scheduled for elective oral surgery. All patients required the extraction of one lower third molar (+ an ipsi-lateral upper) under local anaesthetic. Plain prilocaine 4% without vasoconstrictor was used in all cases as a standard local anaesthetic. The mandibular third molar had to be impacted such that bone removal was required. Standard 12-lead ECG recordings were made at the screening visit, and 30 minutes post-operatively. Patients were then asked to indicate when they felt any post-operative discomfort and were prescribed analgesics when they developed at least moderate pain. In this study patients were administered one of three analgesics: Ibuprofen 400 mg, Pregabalin (50 mg or 300 mg) or placebo (Fig. 3).

One hundred and ninety-eight patients were recruited in the oral surgery department of Cardiff Dental Hospital. Standard inclusion/exclusion criteria were used and all patients had to have a body mass of 50 kg or more.

Tracings were performed in each of the patients with the use of a 12-lead ECG and a 2-minute rhythm strip was recorded. The ECGs were carried out by an ECG technician and then analysed by a consultant cardiologist (AGS) (Fig. 4).

#### RESULTS

#### Screening visit abnormalities

None of the pre-surgery findings were clinically significant and all patients

were asymptomatic. However, of the 198 patients studied, the ECGs were considered to show minor abnormalities in 44 patients (Table 1) (Fig. 5).

# Post-operative ECG changes

Abnormalities occurred in a total of 60 patients (Tables 2 and 3).

#### DISCUSSION

Of one hundred and ninety-eight patients studied, ECG abnormalities were present in 44 patients on the screening visit and in 60 patients 30-45 minutes post study medication. Of these, no patient was regarded as having a significant abnormality requiring treatment or further investigation before surgery. Only four had significant ECG changes after surgery and no patient reported any cardiac symptoms. Most of the minor abnormalities were unaffected by the surgery or analgesia and were probably of no significance.

Interestingly, non-specific ST elevation was noticed in seven patients during the screening visit and in seven patients following analgesia. The changes in the shape of ST segment and T-wave should

Table 3 ECG abnormalities pre- and post-study medication						
Study medication	No. pt	Screening visit	30 mins post dose	Cardiologist analysis		
A,B, C,D	A(2),B(5),C(7),D(6)	rsR complex	rsR complex only C(1) normal	Represent a minor delay in ventricular polarisation It should be regarded as normal and related to drug study		
A,B,C,D	A(2),B(6),C(2),D(1)	Sinus arrhythmia(1),B(2	Sinus arrhythmia	This is a common finding in normal healthy young adult. Unrelated to drug study and is a normal variant.		
B,C,D	B(2),C(3),D(2)	ST segment has a high take off in the chest leads(2-3 mm) in B,C,D	The same in(C,D) Greater in B	Normal variant , unrelated to drug study		
А, В, С	A(4), B(1),C(1)	P wave axis abnormal	P wave axis abnormal	Normal variant which may imply sinus node dysfunction, can be ignored unless symptomatic.		
C,D	C(2),D(3)	C(1),D(2)normal D(1)repeated atrial premature beats C(1)atrial premature beats	*single atrial premature beats *continued *normal	Unlikely to be related to drug study, it is a normal phenomenon		
A,C	A(1),C(2)	Short PR intervals with slurring of upstroke in the inferior leads	Less obvious in A Continued in C	This may represent an accessory path way between atria and ventricle. Unrelated to drug study in asymptomatic patients it can be regarded as normal		
C,D	C(1),D(1)	normal	ST depression in inferior leads maxi- mum 2mmwith some reciprocal ST elevation in V4-V6 (C) Minor ST depression in 11,111 and AVF with no reciprocal changes in the chest leads	This may be a reaction to anaesthesia, surgical stress or drug study. It may also represent asymptomatic coronary artery disease. It was clinically significant therefore pt referred to cardiologist		
A,D	A(1),D(1)	A(normal QTc 0.41sec) D(upper limit of normal for QTc 0.44-o.45sec)	A(slight prolongation of QTc 0.44sec) D(continued)	Unlikely to be related to drug study. No evidence of QTc prolongation associated with study drug.		
B,D	B(1),D(1)	normal	Sinus bradycardia (34-45 mins)	This is unlikely to be related to drug study and of no long term significance		
С	C(1)	Two ventricular premature beats(LBBB morphology)	Sinus bradycardia (53/mins)	Unrelated to drug study and of no clinical importance.		
В	B(1)	Upsloping ST segment elevation in inferior and lateral chest leads	Showed identical features	Unrelated to drug study, it is a normal variant.		
D	D(1)	normal	RBBB pattern with broad QRS(180ms) and t wave inversion	This Can be associated with Brugada syndrome and it is more likely related to the stress of surgery or related medication. GP informed		
С	C(1)	normal	An acute injury pattern with marked ST elevation (>5-8 mm) in V2 and 2-3 mm in V1.	This is atypical prinzmetal angina and may reflect asymp- tomatic coronary artery disease. It may be related to the drug study, which induced coronary artery spasm.		

be interpreted with great caution because of distortion produced by the recording system and by changes in position and activity.<sup>13</sup>

An abnormal P-wave axis was noticed in six patients both on their screening visit and post-analgesia recordings. This implies that either the sinus node was in an abnormal position or that atrial depolarisation was not initiated by the sinus node.

Short PR intervals with short delta waves were noticed in three patients. These abnormalities were unaffected by the surgical and anaesthetic process. This represents an accessory electrical pathway between atria and ventricles. The coexistence of a short PR interval and asymptomatic tachycardia is called Wolff Parkinson White syndrome. The prevalence of Wolff Parkinson White syndrome in the adult population is approximately 0.3%.14 In the current study, three patients (1.5%) showed the ECG features of Wolff Parkinson White syndrome but all were asymptomatic with no history of palpitation. In a healthy adult, this implies that the accessory pathway does not have the electrophysiological characteristics to allow the development of supraventricular tachycardia and therefore can be ignored.

A prolonged PR interval was not found in any of the study subjects.

Sinus arrhythmia was noticed in 11 patients 30-45 minutes post medication, whereas it was present in only three patients during screening visit, but it is a very common finding. Sinus arrhythmia has been renamed irregular sinus rhythm by the World Health Authority Working Party on terms relating to cardiac rhythm.<sup>15</sup>

Atrial premature beats were found in 28 of 50 patients (56%)<sup>3</sup> and it was noticed that a total of 260 of 299 patients (87%) had one or more atrial premature beats.<sup>5</sup> Finally, ECG abnormalities have been detected as a premature atrial contraction in 1.6% of healthy young adult outpatients.<sup>16</sup> This abnormality was noted on four occasions in the current study and was not considered to be related to the medications.

Electrocardiographic signs of left ventricular hypertrophy (R v2+S v5 >35 mm) were detected in two patients without ST changes. However, these changes are not uncommon in a healthy, slim young adult and are considered to be within normal variation.

Minor sinus bradycardia was noticed in three patients (43-55 minutes) but this was unlikely to be of clinical importance in the absence of symptoms and was unrelated to any medication.

Only one patient showed two ventricular premature beats (LBBB morphology); this was not present in 30-45 minutes post drug regimen but there was relative sinus bradycardia. Ventricular ectopic beats are very common. The morphology suggests an origin in the right ventricular outflow tract. This can be found in minor forms of right ventricular dysplasia but, in the absence of symptoms or a positive family history, further investigation is unnecessary.

In total, only four patients showed abnormalities that the cardiologist thought might be related to the surgery, drug study, psychological stress or the effect of local anaesthesia. The effect of oral surgery under local anaesthesia on the heart rate has been the subject of sporadic reports over the years.<sup>2-4</sup> ECG changes have also been associated with the use of local anaesthesia during oral surgery.<sup>4</sup> In this study, prilocaine 4% was used without vasoconstrictor in all cases as local anaesthetic. Although the agent contains no vasoconstrictor, several authors have demonstrated that vasoconstrictors in the local anaesthetic do not increase the incidence of arrhythmias.<sup>2</sup> Interestingly, the cardiovascular stress of extraction under local anaesthetic, assessed by the heart rate and on the occurrence of arrhythmias, is much less than under general anaesthesia.4

One ECG abnormality was reported (in a patient who received 300 mg of pregabalin post-operatively) as an acute injury pattern with marked ST elevation (>5-8 mm) in V2 and 2-3 mm in V1. This had completely resolved two hours later. The patient was referred for cardiological assessment and is awaiting an exercise thallium scan. The aetiology of this cannot be certain.

Finally, in one patient the screening ECG was normal but the 30-45 minutes post dose (Ibuprofen 400 mg) the ECG showed

a RBBB pattern with broad QRS (180 mm) and T- wave inversion. This can be associated with Brugada syndrome but is more likely to be related to the stress of surgery or the medication. Again, however, there is little reason to relate it to the analgesic.

### CONCLUSION

This study has shown that ECG changes in clinically healthy individuals are quite common. The stress of dental surgery and the possibility that local anaesthetics or analgesics may directly affect the myocardium should always be borne in mind by the surgeon. Even though the majority of variations are within normal limits a small number of the cases detected in this study were clinically significant and one case was potentially serious. This research gives no suggestion that a specific analgesic may have induced any of the cardiac arrhythmias that were seen.

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