# ELECTROCARDIOGRAPHIC CHANGES DURING EXTUBATION

## A STUDY OF ELECTROCARDIOGRAPHIC PATTERNS DURING ENDOTRACHEAL ANESTHESIA INCLUDING THOSE SEEN DURING INTUBATION, ENDOTRACHEAL SUCTION, AND PARTICULARLY EXTUBATION

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It has frequently been stated as a matter of anesthetic dogma that, from the standpoint of reflex cardiac activity, endotracheal intubation is more safely performed during deep rather than light anesthesia (1). Reid and Brace (2) stated that circulatory disturbances, as evidenced by electrocardiographic tracings of arrhythmias, are more frequently seen during light anesthesia and that they are due to a reflex effect either on the cardiovascular center itself or on the coronary arteries. Gillespie (3) stated that the facts offered by these authors suggest a further reason, other than facility in laryngoscopy, for which intubation is more safely performed during deep than light anesthesia. Hill (4) concluded from electrocardiographic studies that arrhythmias are chiefly a feature of induction and tend to disappear as anesthesia is deepened.

As a corollary to these tenets, it has been assumed that endotracheal *extubation* during light anesthesia also constitutes a hazardous procedure. Apparently attesting to this belief is a recent report by Schumacher and Hampton (5) of five instances of cardiac arrest occurring during extubation under light anesthesia and attributed by these authors to reflex vagal asystole.

The purpose of this study was to evaluate by electrocardiography any disturbances of cardiac function which might occur during extubation under light anesthesia and to compare these with whatever similar changes might also occur during intubation and maintenance of anesthesia in the same patients.

### Method

Forty-one subjects for investigation were picked at random. The only requisite for selection of each subject was that he was to have an

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operation requiring endotracheal anesthesia. The subjects' ages ranged from 5 to 74 years, the average being 48 years. Twenty-seven were females.

All the patients were prepared for anesthesia and operation in the usual way. Preoperative medication consisted of various drug and dosage combinations, each of which was selected for the individual patient according to accepted criteria for satisfactory preanesthetic preparation and with no intent to alter the experimental results. Morphine,

TABLE 1

| No. Cases | Induction | Intubation No. EKG Changes | Maintenance | Suction No. EKG Changes | Extubation No. EKG Changes | Total No. of EKG Changes |
|---|---|---|---|---|---|---|
| 4 | Curare-pentothal | 1 1R / 0A | Cyclopropane | 4 3R* / 2A† | 2 1R / 1A | 4 3R / 3A |
| 2 | Curare-pentothal | 2 1R / 1A | Cyclopropane→nitrous oxide | 2 2R / 0A | 1 1R / 0A | 2 2R / 1A |
| 5 | Curare-pentothal | 1 1R / 0A | Cyclopropane-ether→nitrous oxide | 0 0R / 0A | 2 2R / 1A | 2 2R / 1A |
| 1 | Curare-pentothal | 0 0R / 0A | Cyclopropane→ether→ether | 1 1R / 0A | 1 1R / 1A | 1 1R / 1A |
| 1 | Curare-pentothal | 1 1R / 0A | Ether→nitrous oxide | 0 0R / 0A | 1 1R / 0A | 1 1R / 0A |
| 21 | Curare-pentothal | 11 11R / 1A | Nitrous oxide | 7 7R / 0A | 7 6R / 1A | 15 15R / 2A |
| 1 | Pentothal | 1 1R / 0A | Nitrous oxide | 0 0R / 0A | 0 0R / 0A | 1 1R / 0A |
| 2 | Pentothal-cyclopropane | 2 2R / 0A | Nitrous oxide | 1 1R / 0A | 2 2R / 1A | 2 2R / 1A |
| 1 | Cyclopropane-ether | 0 0R / 0A | Ether | 0 0R / 0A | 1 1R / 0A | 1 1R / 0A |
| 2 | Vinethene-ether | 1 0R / 1A | Ether | 2 2R / 0A | 2 2R / 0A | 2 2R / 1A |
| 1 | Pontocaine | 0 0R / 0A | Pontocaine | 0 0R / 0A | 0 0R / 0A | 0 0R / 0A |
| 41 | Total | 20 18R / 3A | Total | 17 16R / 2A | 19 17R / 5A | 31 30R / 10A |

* R—Rate change.
† A—Arrhythmia.

demerol or codeine with or without previous sedation with nembutal was given with atropine or scopolamine one to one and a half hours preoperatively.

Control electrocardiographic tracings, employing leads I, II and III, were made with a direct writing Viso-cardiette (Sanborn) for each patient immediately before induction of anesthesia. Additional tracings, employing only lead II unless otherwise indicated, were made during (1) intubation (2) endotracheal suction immediately prior to extubation, and (3) extubation.

Various combinations of anesthetic agents and methods were employed (table 1) and the depth of anesthesia at the time the electrocardiographic tracings were being recorded varied from patient to patient and in each patient. Only during extubation was the depth of anesthesia relatively constant in all patients. Extubation was performed on all the patients during very light anesthesia, so light in fact, that three of the tracings recorded during extubation were difficult to evaluate because of distortion produced by the patients' "bucking."

Immediately after operation, while each patient was still on the operating table, electrocardiographic tracings employing leads I, II and III were recorded for comparison with the preoperative control tracings.

During the recording of all electrocardiographic tracings one observer palpated the radial or carotid pulse of the patient and recorded his findings. The tracings were interpreted by two medical residents and a consulting cardiologist in conjunction with one of us (J. G. C.) who also estimated the depth of anesthesia during each electrocardiographic recording and followed each patient's course after operation. Electrocardiographic tracings showing cardiac rhythms of ectopic origin or changes in pulse rate of more than 5 beats per minute were classified as abnormal. Increases in pulse rate were classified as "relative" or "true" tachycardias, depending upon whether the change resulted in a rate below or above 100 per minute. Likewise, decreases in pulse rate were classified as "relative" or "true" bradycardias depending upon whether the change resulted in a rate above or below 60 per minute.

## RESULTS

*During Intubation.*—Of the 41 patients studied, 20 demonstrated electrocardiographic changes during intubation which could be classified. These consisted of three abnormal cardiac rhythms of ectopic origin (one bigeminal rhythm, two nodal rhythms), and eighteen rate changes (thirteen "true" tachycardias, three "relative" tachycardias, two "relative" bradycardias). One of the nodal rhythms occurred in conjunction with a "relative" bradycardia in one patient. The distribution of electrocardiographic changes among agents and methods used is shown in table 1.

Eighteen patients of the group studied were considered by pre-

operative electrocardiographic or clinical evidence to have some form of cardiac abnormality. Eight of the twenty electrocardiographic changes during intubation occurred in this group. The other twelve changes during intubation occurred in the remaining 23 patients, who had no evidence of cardiac abnormality. Ectopic rhythms and rate changes occurred in both groups.

Twenty-one patients of the group studied were given topical anesthesia in the form of 1 per cent pontocaine sprayed into the pharynx, larynx and trachea after induction and immediately before intubation. Ten of the twenty electrocardiographic changes occurred in this group. In the other 20 subjects who did not receive topical anesthesia, ten electrocardiographic changes occurred during intubation.

*During Suction.*—Of the 41 patients studied, rate or rhythm changes developed in 17 during endotracheal suction before extubation. These changes consisted of two abnormal cardiac rhythms (one premature ventricular contraction and one 1 degree A–V block), and sixteen rate changes (nine "true" tachycardias, six "relative" tachycardias and one "relative" bradycardia). The "relative" bradycardia occurred in conjunction with the A–V block. The distribution of electrocardiographic changes among the agents used is shown in table 1.

Six electrocardiographic changes occurred in the 18 patients with abnormal hearts and eleven occurred in the remaining 23 patients who had no preoperative evidence of heart disease. The two abnormal rhythms present during suction occurred in patients with abnormal hearts.

*During Extubation.*—Of the 41 patients studied, 19 showed a change in rate or rhythm during extubation. These were comprised of five abnormal rhythms of ectopic origin (three premature ventricular contractions, two premature auricular contractions) and seventeen rate changes (fifteen "true" tachycardias alone and two "relative" bradycardias followed by tachycardias). Two of the premature ventricular beats and one of the premature auricular contractions occurred in conjunction with "true" tachycardias (table 1).

Seven electrocardiographic changes occurred in the 18 patients with abnormal hearts and twelve occurred in the remaining 23 patients who had no evidence of heart disease. Changes in rate and rhythm occurred in both groups.

## COMMENT

The advantages of having the patient in a reactive state at the termination of anesthesia are multiple. The low incidence of pulmonary morbidity in the patient who is able actively to clear his pulmonary tree of secretions is reason enough for the anesthesiologist to attempt to have the patient awake at the termination of the surgical procedure. If, however, extubation in light planes of anesthesia renders the patient susceptible to serious reflex cardiac disturbances, then it would appear that prompt return to consciousness after opera-

tion to minimize postoperative pulmonary morbidity should be sacrificed in favor of cardiac safety.

Our studies tend to deny the alleged cardiac dangers of extubation during light planes of anesthesia. With the technics employed in this clinic, the arrhythmias which did occur were so fleeting in character, and the postoperative course was so free from complications from the standpoint of cardiac dysfunction, that we feel relatively safe in extubating patients during light anesthesia.

The practice of ventilating the patient's lungs with 100 per cent oxygen before any endotracheal manipulations may well be the answer to the relatively low incidence of electrocardiographic changes which we encountered in this study. Sloan (6) emphasized in his experimental work on dogs how difficult it is to produce vagal asystole in the absence of anoxia. Electrocardiographic changes suggestive of vagal overtone, for example, instances of "true" bradycardia, did not develop in any of the patients whom we studied. One can discount the antivagal effects at the time of extubation of preoperative administration of atropine on the basis of the prolonged duration of many of the surgical procedures. Extubation in many of the cases was performed at a time when preoperative medication could no longer be exerting an appreciable effect. Therefore, it may be assumed that, in the absence of anoxia, reflex cardiac disturbances during endotracheal manipulations are likely to be of infrequent occurrence and of a transient nature even without significant vagal depression.

Attempts to correlate cardiac dysfunction, when it occurred, with agents and methods, site of operation and the patient's cardiac status were made, not only for endotracheal extubation but for all phases of endotracheal manipulations.

*Agents and Methods.*—The incidence of electrocardiographic changes during endotracheal manipulations under anesthesia with inhalation agents alone was higher than when intravenous pentothal was used in conjunction with the inhalation agents. The incidence of electrocardiographic changes during endotracheal manipulations under pentothal-nitrous oxide anesthesia was lower than when cyclopropane or ether was employed as the primary agent. Strangely enough, all 4 patients in whom ether was the primary agent demonstrated classifiable electrocardiographic changes during endotracheal manipulations whereas of the 12 patients in whom cyclopropane was the primary agent only 50 per cent showed electrocardiographic changes.

Intravenous procaine provided no absolute prophylaxis against cardiac arrhythmias, and the application of topical pontocaine to the larynx apparently did not alter the changes occurring during endotracheal intubation. Again, the practice of ventilating the patient's lungs with oxygen before intubation seemed to offer the greatest protection against the occurrence of arrhythmias.

*Site of Operation.*—Electrocardiographic changes during endo-

tracheal manipulations occurred more frequently in patients undergoing thoracic and upper abdominal operations, particularly surgical procedures about the biliary tract.

*Cardiac Status.*—Unlike the findings reported by Kurtz, Bennett and Shapiro (7), patients who were classified by us as being in an abnormal cardiac status preoperatively fared somewhat better, from the viewpoint of cardiac arrhythmias, than those patients who were considered to have normal hearts. The reason for this is just as obscure as the reason why patients who have abnormal cardiac rhythms before the induction of anesthesia sometimes assume normal electrocardiographic patterns once anesthesia is established.

To attach any grave significance to the electrocardiographic changes that appeared during endotracheal manipulation in our group of patients is difficult. That arrhythmias do occur during anesthesia with or without endotracheal manipulation has been attested to by the mass of literature already accumulated on the subject. That unrecognized arrhythmias, not palpable at the wrist or temple, occur is also well known. At least six of the demonstrable electrocardiographic changes in our group of patients were not detected at the peripheral pulse. Perhaps we are unduly concerned about the problem of cardiac arrhythmias during anesthesia. We do not deny, however, that sudden cardiac fatalities do occur, and despite the apparently innocuous results of our study we continue to view endotracheal manipulations with respect, and emphasize careful observation of cardiac rhythms, gentleness in technic and above all else, the avoidance of anoxia. We do not believe that it is necessary to sacrifice prompt recovery after operation for cardiac safety by extubating under deep anesthesia.

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