Simple Optical Methods for the Recognition of Atrial Flutter, Especially at Slow Atrial Rates

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Many electrocardiographers have discussed the differentiation of atrial flutter from atrial tachycardia with block. Some have concluded that there is no difference; others, including ourselves, hold the opposite view. We find the methods described here useful in making the distinction in practice and of interest in their bearing on the theoretical mechanism of atrial flutter.

There are three areas of confusion relevant to the differentiation. Much of the first, intellectual confusion, could be dispelled by a return to the well-phrased description of flutter by Sir Thomas Lewis: "The Auricular Complexes in Electrocardiograms.—The beating of the auricles usually displays itself characteristically in these curves. At each cycle in leads II and III the curve ascends sharply to a blunt summit and returns more gradually. . . . The gentle downsweep is often notched. In lead I the complexes are usually diminutive. . . . Another and important feature to which I have drawn attention is that the complexes are contiguous; the string is moving constantly and rests for no measurable period on a base line; as soon as one complex is complete the next starts, and this action is continued even throughout ventricular systole. . . . Each complex is a duplicate of the last in form, though this is disguised when ventricular complexes fall with them; the length of the complexes is wonderfully uniform. . . . Another striking feature is that the.

Figure 1

Strips of limb lead II taken in rapid succession from a patient with classical atrial flutter: (top) standard method of recording at 10 mm/mv, 25 mm/sec; (middle) 10 mm/mv, 50 mm/sec; (bottom) 5 mm/mv, 50 mm/sec. Note simulation of atrial tachycardia in bottom strip as the hypotenuse of 1 mv/sec approaches the horizontal, from 20° to 5°. Time markings in all standard figures 0.04 and 0.20 sec. Record obtained by Frederic S. Glazener, M.D.
forms of the auricular complexes in curves taken from different patients usually present a curious and often remarkable resemblance . . . ."

Secondly, the record of course must reveal atrial activity separable from the ventricular complexes; if we follow Lewis, this should be in the limb leads rather than precordial ones.

The remaining source of confusion in practice is that of deciding whether or not the trace "rests for no measurable period on a base line," especially when the atrial rate is slower or its voltage lower than usual. Then, by principles of trigonometry, the angle of "gentle downsweep" of the atrial flutter trace from the horizontal is less than usual, to such an extent that it appears as though it were isoelectric and thus the record fails to resemble that of classic flutter. This, the main point of the present report, is illustrated by figure 1 which shows three strips of lead II taken in rapid succession from a patient with flutter. In the lower left corner of each strip, vertical and horizontal heavy lines denote 1 mv and 1 sec, respectively, with slopes of 1 mv/sec at approximately 20°, 10°, and 5° to the horizontal. The third strip erroneously suggests atrial tachycardia at least as much as it does flutter.

![Figure 2](https://example.com/figure2.jpg)

**Figure 2**

Appearances produced in columns of slopes (approximately 40°, 20°, 10°, and 5° from left to right) by cylindrical lenses of different diameters (1 to 0.5 inch) and shapes as indicated on the left.

![Figure 3](https://example.com/figure3.jpg)

**Figure 3**

Appearances of the flutter waves and slopes of 1 mv/sec from figure 1 as altered by cylindrical lenses on the second and third strips.
Methods

From figure 1 it is apparent that, in doubtful situations, the tracing should be obtained either at less than usual velocity of recording paper (the precision of photographic versus direct-writing techniques may be questioned here, but will not be discussed further) or at increased amplification. The latter, more practical method, in fact was used by Jolly and Ritchie4 in their historic patient in whom flutter first was recognized.

Unfortunately, the electrocardiographer often is confronted by a record obtained under standard conditions, with no opportunity to repeat the tracing more advantageously. Under these circumstances we have found two simple optical methods to be of aid in the discovery of flutter in certain records, or in the confirmation of a diagnosis of atrial tachycardia with block in other instances in which there is indeed an isoelectric base line in leads II and III.

The first method is simply one for shortening the apparent length of the tracing to simulate a recording at reduced velocity. One merely sights along the electrocardiographic strip. Distortion is a disadvantage, nor is it easy to obtain satisfactory measurements or photographic reproduction; on the other hand, no special equipment is required and questionable records may be examined quickly.

The second method achieves the same end in a somewhat more satisfactory way, by simulation of a recording at higher amplification (for example 20 to 30 mm/mv). It does require a bit of special equipment, but this is only a convex cylindrical lens. At little cost, one may select a rod or a plano-convex “line magnifier” or “magnifying bar” in glass or transparent acrylic resin from a number of readily available sizes. Figure 2 shows from above downward the magnifications produced, in columns of slopes at 40°, 20°, 10°, and 5° from left to right, by cylinders and plano-convex cast acrylic rods lying horizontally on the object; diameters range from 1 inch (above) to 0.5 inch (below), and shapes in cross-section are indicated to the left. Distortions are apparent as well, but these may be avoided or minimized by utilizing the centers rather than the edges of the rods. We also have obtained satisfactory results with plano-convex lenses of glass, focal length 44 to 110 mm, held appropriately above the electrocardiograms.

Results

Figure 3 shows the effects of viewing the second and third strips of figure 1 through cylindrical lenses: the record of atrial activity more clearly is continuous, an effect the reader may exaggerate further by using his own cylindrical lens for additional magnification.

Figure 4

Roentgenograms of the chest and corresponding electrocardiographic limb leads II and III from one patient on May 10, 1956, July 28, 1961, and July 17, 1964. Atrial rates in flutter were 214, 182, and 153 per minute, respectively, as the right atrium increased in size. Note simulation of atrial tachycardia by final lead II, and see figure 5.
Figure 4 presents roentgenograms of the chest and accompanying electrocardiographic leads II and III of a woman with rheumatic tricuspid stenosis. As the right atrium grew to enormous size (confirmed at operation by Dr. Norman Shumway) from May 10, 1956, to July 17, 1964, the atrial rate declined without quinidine or procainamide from 214 through 182 to 153 per minute, in agreement with a relationship reported previously. A number of unsuspecting electrocardiographers made a misdiagnosis of atrial tachycardia with A-V block when permitted to examine only lead II from the record of the last date. Figure 5 shows this lead as recorded (top), magnified about 2.5 times (middle strip) and then about 5 times (bottom) by a cylindrical lens; the continuous atrial activity of flutter is increasingly apparent.

Figure 6 shows limb lead II during temporary restoration of cardiac activity subsequent to standstill which complicated acute myocardial infarction in a woman of 71 years of age. Its third and fourth strips are shown in figure 7 as they appear to one sighting along them by the method illustrated; its third strip under a lens is represented in figure 8. Atrial flutter seems to be present, at a cycle length of 0.68 sec or rate of 88 per minute.

Discussion

While there are clinical differences between the natural histories of atrial flutter and atrial tachycardia with block, the electrocardiographer often has neither past nor future to guide him and must or should make the distinction upon a single tracing, usually one
Strips of limb lead II from electrocardiogram following cardiac standstill. Note slow atrial rate of 88 per minute, not appreciated as flutter at first despite continuous electrical activity.

Recorded at the standard 25 mm/sec and 10 mm/mv. The diagnosis of flutter then becomes a matter of visual discrimination: the tracing either does or does not conform to certain criteria, preferably those of Lewis. Slow atrial rates in flutter of trigonometric necessity may alter the slope of "the gentle downsweep" toward its apparent extinction as a horizontal isoelectric line. Then, such curves will no longer "present a curious and often remarkable resemblance" to those of flutter at the usual atrial cycle length of 0.2 sec (300 per minute) and the diagnosis of flutter may give way erroneously to atrial tachycardia.

Partially owing to this phenomenon, quite arbitrary rate limits have been proposed; atrial rates slower than these often are regarded as those of atrial tachycardia rather than flutter for no reason other than the rate itself, together with the attendant difficulty in detection of continuous atrial activity. Historically, other reasons for the premature and erroneous imposition of arbitrary rate limits seem important. First, one almost senses the anguish of Sir James Mackenzie, both as a clinician and as the authority on interpretation of arrhythmias by means of the polygraph, when young Lewis confronted him with tracings from Mackenzie's own patients of flutter recorded by, and identifiable only by, the new electrocardiograph: "It is imperative, however, that its [flutter's] recognition should be made on other evidences than that of the electrocardiogram, for there is no opportunity of examining the vast majority of cases by this method," whereas Mackenzie easily could determine atrial rates by records of the jugular pulse. Somewhat later, during the period of widespread ac-
ceptance of the circus movement hypothesis as the mechanism responsible for flutter, it was held that flutter “could not” exist below certain rates because the mechanism then would cease to support the arrhythmia. Inadequate or no allowances apparently were made for the possibilities of unusually long pathways or slow velocities of excitation wave.

Figure 7
Third and fourth strips of figure 6, as viewed by one sighting along the record. The appearance of flutter is less obscure.
Thus, there seems to be no valid reason for excluding the diagnosis of flutter because of slow atrial rates per se. Lewis himself wrote of 220 per minute in untreated cases, and others observed flutter rates of 134 per minute in the presence of quinidine. An atrial rate of 88 per minute (figs. 6 and 8) seems credible in relation to the abnormal physiological processes associated with cardiac standstill.

In the extensive literature on the differentiation of flutter from atrial tachycardia, much of it recently reviewed, one may find with the cylindrical lens many instances of the former regarded by some authors as examples of the latter. The reverse error seems uncommon, and even with the lens it is clear that many isoelectric lines are truly so. A word of caution seems appropriate: In the presence of atrial tachysystole with regular 2:1 block, that atrial cycle associated with a ventricular T wave should not be examined with the lens for continuous “atrial” activity; the base line under examination should not wander; and use of the edges of the lens should be avoided lest distortion become misleading.

Another optical method applicable to the study of flutter is that of inverting portions of the record by means of a mirror (preferably a first-surface one), or by placement of the cylindrical lens so high above the record that it yields an inverted image. Upon inversion, certain records reveal the typical appearance of atrial flutter rather than paroxysmal atrial tachycardia. With electrocardiograms of flutter, inversion of aV\(_R\) and V\(_{1-2}\), especially the former, by one of these methods usually produces a resemblance to the classic appearance of leads II and III (or aV\(_F\)). Nothing definitive has been written on the appearance of precordial leads in flutter. Such leads are valuable in the detection of atrial
activity but seem much less so in the differentiation of atrial arrhythmias.

Finally, the considerations and results noted here bear on the $T_a$ wave as an explanation for the classic electrocardiographic appearance of flutter. We submit that the evidence for that point of view is based on an optical illusion whereby the "gentle downsweep" at slower than usual atrial rates resembles, but is not truly, an isoelectric line. From our argument it follows that the objection to the vectorial analysis of flutter from special chest leads by Lewis and associates would be countered and that analysis would be supported as valid evidence for circus movement in atrial flutter. The demonstration of continuous electrical activity of the atria in flutter at rates down to 88 per minute itself favors a circulating wave; otherwise one must postulate a conduction velocity nicely adjusted to the rate of an ectopic focus.

Summary

Simple optical methods, particularly the use of a cylindrical lens, are described which facilitate the examination of electrocardiograms and the differentiation of atrial flutter from atrial tachycardia with block. Results of utilizing the methods indicate that what may seem to be an isoelectric line of the latter is sometimes but an optical illusion, especially at slow atrial rates. Continuous atrial electrical activity of flutter has been detected at atrial rates as slow as 88 per minute. Some of these findings are relevant to certain considerations on the mechanisms of atrial arrhythmias.

References


Truth requires no other authority than that which it contains within itself. If the witness of the past can be brought forward to support it, it more easily finds recognition and more easily gains currency than without that witness. But a truth must never be violently interpolated into the thought of an earlier period in order that it may there find justification. In itself Truth possesses such power of carrying conviction that it has no need to turn to History to beg for a recommendation.—Albert Schweitzer: Indian Thought and Its Development, New York, Henry Holt and Company, 1936, p. 243.
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