CASE REPORTS

Augmentation of Electrical Alternans with Lowering of the Heart Rate in Massive Pericardial Effusion

A Report of a Case

By Dennis V. Cokkinos, M.D., Constantine Kelesides, M.D., John Sia terlis, M.D., and Evangelos Halimos, M.D.

SUMMARY

A patient with massive pericardial effusion and electrical alternans was studied. Intravenous administration of 8 mg practolol produced a decrease in heart rate from 120 to 87 beats/min, with increase of the alternans. The postulation that tachycardia is necessary for the appearance of electrical alternans in cardiac tamponade cannot be supported from this finding.

Additional Indexing Words:
Practolol Beta-adrenergic blocking agents

Electrical alternans is characteristic of pericardial effusion, especially of neoplastic origin. This phenomenon has been explained by increased cardiac motion or rotation due to the excessive fluid in the pericardium. This assumption has been supported by studies employing reflected ultrasound.

In addition to the excessive motion of the heart, rapid heart rate has been considered a critical factor in the appearance of electrical alternans. It has been pointed out by McGregor and Baskind and Littman and Spodick, and clinical experience has borne out that in all reported cases of electrical alternans due to pericardial effusion heart rates above 100 beats/min have been observed. According to these authors, the heart acts like a pendulum; electrical alternans occurs when the heart rate is exactly twice the normal oscillatory heart rate, which they estimate at 50 to 65 beats/minute. Feigenbaum et al. also postulated that, in addition to the excessive pericardial fluid, a rapid heart rate may be necessary for the occurrence of this phenomenon.

We recently observed a patient with massive pericardial effusion and electrical alternans and studied the effects of heart rate changes on this phenomenon.

Case Report

A 72-year-old female was hospitalized for progressively increasing dyspnea. She was a cachectic woman in continuous respiratory distress. Her heart rate on admission was 120 beats/min and arterial blood pressure 100/80 mm Hg. The pulse was normal. The cardiac sounds were muffled and the cardiac apical impulse could not be palpated. She was afebrile.

The venous pressure was measured at 26 cm H2O. In the chest X-ray an enlarged heart with small hila was seen (fig. 1). In the electrocardiogram, low QRS voltage, ST-segment changes suggestive of pericarditis and electrical alternans were seen. The heart rate was 105-110 beats/min (fig. 2). The diagnosis of pericardial effusion with tamponade was made. No medications of any kind had been given previously.

Two hours after admission, a total of 8.0 mg of practolol was slowly administered intravenously, at increments of 2.0 mg per minute, with continuous monitoring of the cardiac frequency and blood pressure. Lead V4a was recorded, at double sensitivity for greater clarity. The heart rate progressively decreased from 120 to 87 beats/min. The blood pressure did not change, nor did paradoxical pulse or
Enlarged cardiac silhouette with absence of hilar congestion, suggestive of pericardial effusion.

Pulsus alternans appear. With the lower heart rates the frequency of electrical alternans did not diminish; in fact, it increased (fig. 3).

One hour later pericardiocentesis was performed, and 330 ml of deep yellow fluid were aspirated. The patient experienced immediate relief. The venous pressure decreased to 8 cm H₂O, and the arterial pressure rose to 120/80 mm Hg. On the electrocardiogram, the QRS voltage increased, ST-segment elevation diminished and the electrical alternans pattern was markedly attenuated. The heart rate did not change appreciably (fig. 4).

Examination of the pericardial fluid revealed numerous lymphocytes, eosinophils and atypical cells suggestive of malignancy. First and second strength PPD tests were negative. The patient refused further diagnostic studies and was empirically placed on prednisone, with moderate clinical improvement. After leaving the hospital at her demand, she was lost to follow up.

**Discussion**

In this patient a significant reduction in heart rate did not result in the disappearance, but actually in the increase of electrical alternans. According to Littman and Spodick,⁹ in all reported cases of electrical alternans caused by pericardial effusion, heart rates equal to or above 100 beats/min have been observed. They suggested that oscillation of the heart with a periodicity equal to one-half the heart rate resulted in a sufficient shift in the position of the heart to produce the observed changes in the electrocardiogram.¹ Feigenbaum et al.² postulated that during tachycardia the heart may not have time to return to the usual position at the beginning of each cardiac cycle. According to our findings, tachycardia cannot be considered as a critical factor in producing electrical alternans.

Practolol is a cardioselective beta-adrenergic blocking agent with only mild myocardial depressant effects. At the doses used in our study, it has been found to alter cardiac contractility minimally.⁴, ⁵ While electrical alternans has been associated with decreased cardiac contractility, it is improbable that a negative inotropic influence of practolol could have contributed to the increase of alternation seen in our patient.

It should be remembered that electrical alternans has been produced in isolated myocardial cells:

![Figure 1](image1.png)

![Figure 2](image2.png)

Enlarged cardiac silhouette with absence of hilar congestion, suggestive of pericardial effusion. Electrocardiogram of admission. Alternation of QRS complexes can be seen in leads I, II, III, aV₆, aV₄, aV₂, and V₂-V₆.

![Figure 3](image3.png)

(Upper strip) Constant alternation of the QRS complexes and lesser, nonconstant alternation of the P and T waves can be seen in lead V₅ at double standard. The heart rate is 120 beats/min. (Middle strip) The QRS alternation is enhanced at 92 beats/min following administration of 4.0 mg practolol. (Bottom strip) Further increase of QRS alternation at 87 beats/min after a total dose of 8.0 mg practolol.
Hoffman and Suckling observed this phenomenon at rapid heart rates, but Kleinfeld, Magin and Stein found that it was unrelated to heart rate. Also, the clinical observations of Arya, who noted alternation in cases of aortic stenosis with a slow heart rate, further support our suggestion that electrical alternans in pericardial effusion is not a rate-dependent phenomenon.

Kleinfeld, Stein, and Kossman postulate that an alternation in the rate and extent of transport of ions across the myocardial membrane is involved. Since the beta-blocking agents have been found to reduce digitalis-induced potassium egress from the heart, it is possible that practolol increased the degree of alternation in our patient through a modification of myocardial ion transport.

References


Figure 4

After pericardiocentesis. QRS voltage has increased. Electrical alternans can be seen only in leads V4 and V6.
Augmentation of Electrical Alternans with Lowering of the Heart Rate in Massive Pericardial Effusion: A Report of a Case
DENNIS V. COKKINOS, CONSTANTINE KELESIDES, JOHN SIATERLIS and EVANGELOS HALIMOS

Circulation. 1974;49:1254-1256
doi: 10.1161/01.CIR.49.6.1254

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/49/6/1254

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at: http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at: http://circ.ahajournals.org//subscriptions/