Although considerable controversy existed in the past, it now seems to be generally accepted that following digitalization, the repolarization phase of the electrocardiogram is influenced to a greater extent in the presence of heart disease than in its absence. In the normal heart after digitalis, the typical modification of the ST-T segment is usually seen in leads reflecting the potential variations of the epicardial surface of the left ventricle. These are a shortened QT interval, sagging of the ST segment and a lowered T wave amplitude. It has been suggested that digitalization might uncover previously unsuspected electrocardiographic abnormalities and that these may differ in left, as compared to right ventricular disease. To evaluate more carefully these changes, two groups of patients receiving digitalis were studied for the ST and T vectors. One group had essential hypertension; the other rheumatic mitral valvular disease.

Material and Methods

Twenty-five patients who had been off digitalis for at least one month prior to the initiation of the study were selected. Twelve had rheumatic heart disease; mitral stenosis was the only lesion in 11. These patients were studied by means of cardiac catheterization and one by angiography. One patient, in whom the diagnosis was made clinically, had an insignificant mitral insufficiency as an added lesion. Their ages ranged from 24 to 66 years. There were nine men and three women in this group (I). The right ventricular pressures ranged from 25 to 89 mm Hg systolic and 0 to 10 mm end diastolic. The left atrial (or pulmonary capillary) left ventricular gradient varied from 2 to 26 mm Hg.

Group II consisted of 13 patients with hypertensive cardiovascular disease. All had persistently elevated blood pressures ranging from 140 to 200 systolic and 100 to 135 diastolic, extending for a period of six months to 30 years. In one patient, the hypertension was complicated by mild aortic insufficiency. The ages ranged from 29 to 63 years and included five men and eight women of Caucasian and Negro background. All but one were under treatment with reserpine and thiazides. None was in congestive heart failure. Electrolytes were normal. In all patients a control 13 lead electrocardiogram including lead V4R was taken. Digoxin, 5.5 mg was given orally over a period of seven days. An electrocardiogram was repeated on the eighth day.

All electrocardiograms were recorded with direct writing Sanborn machines and the orientation and magnitude of the T and J vectors was determined in both the horizontal and frontal planes. The method employed was essentially that of Sodi Palleas. Lead V2 was considered to represent the antero-posterior and V6 the transversal component of the dipole. The horizontal plane was derived from these leads. The frontal plane abnormalities were plotted from lead I and aVF, the latter selected as the vertical axis. On each lead at least three
different cycles were studied to prevent accidental errors in measurement. Changes greater than 1 mm occurring after digitalization were considered significant.

Results

A) Orientation of the T Wave Vector

1. Horizontal plane: Group I patients with mitral stenosis had a mean T vector of $+53^\circ \pm 18^\circ$ before, and $+34^\circ \pm 35^\circ$ after digitalization, an insignificant difference (.2 $>$ P $>$ .1).

In the 13 patients with hypertensive cardiovascular disease, digitalization effected an anterior displacement of the T vector in eight (62 per cent) and no change in five. The mean T vector before digitalization was located at $+39^\circ \pm 30^\circ$, and after digitalization $+68^\circ \pm 33^\circ$. These changes in orientation of the T vectors were found statistically significant (P $>$ .02).

2. Frontal Plane: In Group I (mitral stenosis), the T vector orientation rotated superiorly in four patients (31 per cent) after administration of digitalis. In ten patients (66 per cent) there was no change. The mean values were $+42^\circ \pm 25^\circ$ before digitalis and $+28^\circ \pm 34^\circ$ after digitalis (P $>$ .30). The changes were not considered statistically significant. In the hypertensive group, there was an inferior displacement of the T vector in three patients (23 per cent) and no change in the other ten patients (77 per cent). The mean values for the T vector orientation were $16^\circ \pm 41$ before digitalis and $36^\circ \pm 57^\circ$ after digitalis, (P $>$ .30). These changes are not statistically significant.

B) Observations on the Location of the J Vector

1. Horizontal Plane: In the patients with mitral stenosis before digitalization, the J vector pointed to 60° in two cases (16 per cent). Nine patients in this group did not have a significant displacement of the J point. After digitalis, all 12 patients in Group I developed J vectors pointing between 240°-260° with a mean of 249°. The study of the J vector in the patients with hypertension did not reveal any significant changes before or after digitalization. In 11 out of 13 (87 per cent) there was no appreciable J point displacement in this plane. After digitalis, two cases (15 per cent) developed J vectors pointing to 180°. The other ten patients did not show any J vector.

2. Frontal Plane: In the tracings before digitalization in Group I (patients with mitral stenosis), the J vector pointed to 60° in one patient (8 per cent) and no significant displacement of the J point was observed in the remaining 11 patients (92 per cent). After digitalis, the J vector pointed to 210° in nine patients (75 per cent). In two patients (17 per cent) no significant J vector appeared, and in one patient (8 per cent) it pointed to 60°.

In the cases with hypertensive cardiovascular disease, no displacement of J was observed in the tracings before and after digitalization in the frontal plane.

Discussion

The electrocardiograms of individuals without heart disease and normal ventricular gradients show no change in the direction of the T vector following digitalization. Although the magnitude of the T vector is reduced, the QRS-T angle re-
mains unchanged.1,4,13 In a report on the fraudulent use of digitalis in normal subjects to simulate heart disease for purposes of disability benefits, electrocardiograms recorded during digitalis therapy revealed lowered voltage of the T waves and characteristics scooping of the ST segment. The T vector did not show any change in direction. The ST-T configurations were normal after digitalis was discontinued.18 A similar observation was made in two normal siblings ages two years and 16 months who were accidentally poisoned with digoxin.17

In undigitalized subjects with abnormal ventricular gradients, the residual T wave changes after digitalis administration still reveal an abnormally wide QRS-T angle. The measurement of the QRS-T angle can thus be used effectively after, as well as before digitalization as an indicant of an abnormal record.1,4,18

The fact that digitalization affects repolarization in subjects with normal hearts differently than those with abnormal hearts led to the question of whether differences following digitalization may exist between right and left ventricular disease. Subjects with chronic essential hypertension were compared with patients having chronic rheumatic mitral stenosis. The repolarization phase was studied in the electrocardiogram before and after digitalization. An increase in the QRS-T angle was observed in hypertensive patients, 62 per cent showing the horizontal T vector rotating to a more anterior location. In patients with rheumatic mitral stenosis there was a tendency for the maximal vector to rotate posteriorly although the pre- and post-digitalis difference was not significant.

The J vector (ST) changes were more significantly related to the specific ventricle involved. In rheumatic mitral stenosis, 88 per cent showed “J” vector displacement to a mean of 249° ±6° in the horizontal plane after digitalization. These two pointed to 180° in the horizontal plane. Differences also existed in the frontal plane.

The reasons for the changes in the ST vector or J point in digitalized patients with rheumatic mitral stenosis and the significant difference when compared to the hypertensive patients are not known. It is noteworthy that the J point orientation in a recent case report of a digitalized patient with right ventricular hypertrophy due to left atrial myxoma was the same as that seen in rheumatic mitral stenosis.19

![Figure 2: Orientation of the J vectors after digitalization in patients with mitral stenosis. Note the right, posterior and superior displacement of the J point.](image-url)
The greater effects of digitalis glycosides on repolarization in diseased hearts is probably related to the altered electrolyte relationships across the cell membrane present prior to digitalization. There is cellular K+ loss in ventricular failure. The cardiac glycosides affect the K+ and Na+ relationship in the failing heart resulting in a net gain of cellular K+. It is believed that in the normal dog heart digitalis decreases the net inward movement of K+ and the outward movement of Na+, especially in doses above the therapeutic range. The different effects of digitalis on the cellular ionic balance in normals when compared to diseased hearts may well be responsible for the differences in the ST-T alterations following digitalization in normal hearts when compared to those in right ventricular hypertrophy and left ventricular hypertrophy. A comparison with patients who have coronary artery disease is difficult since ST segment shifts are often related to ischemia. A review of the electrocardiograms in digitalized patients with chronic lung disease failed to show the changes in J vector direction seen in rheumatic mitral stenosis.

The digitalis glycosides can thus be effectively used as an indicant of right ventricular hypertrophy on the electrocardiogram or vectorcardiogram of patients with rheumatic heart disease. These criteria are negated when combined hypertrophy due to complicating aortic valvular disease is present.

**Summary**

Digitalization can serve as an indicant of ventricular disease. After digoxin, the maximal T vector was displaced more anteriorly in hypertensive patients (left ventricular disease), whereas it tended to be displaced more posteriorly in cases of mitral stenosis (right ventricular disease).

A highly specific directional J vector pointing posteriorly and to the right in the horizontal plane was present in patients with left ventricular disease. Digitalization thus significantly enhances the electrocardiographic diagnosis of rheumatic mitral valve disease through its specific effect on repolarization events best seen in those leads reflecting the potential variations of the epicardial surface of the right ventricle.

**Resumen**

La digitalización puede servir como un indicador de enfermedad ventricular después de la administración de digoxin. El vector máximo T fue desplazado más anteriormente en pacientes con hipertensión (que afecta el v. izquierdo) mientras que en casos de estenosis mitral (que afecta el v. derecho) tiende a desplazarse más posteriormente.

Un vector direccional I altamente específico dirigido posteriormente y hacia la derecha en un plano horizontal fue observado en pacientes con estenosis mitral reumática. Esta particularidad no fue observada en pacientes digitalizados con afectación del v. izquierdo.

La digitalización facilita pues el diagnóstico electrocardiográfico de las afecciones valvulares reumáticas, mediante su efecto específico sobre la repolarización, manifestado preferentemente en las derivaciones que recogen las variaciones de potencial en la superficie epicárdica del ventrículo derecho.

**Résumé**

La digitalisation peut servir comme indicateur d'une maladie ventriculaire après traitement par Digoxine. Le vecteur principal de l'onde T est situé plus antérieurement chez des malades hypertendus (maladie ventriculaire gauche) alors qu'il tend à être déplacé plus vers l'arrière chez les malades atteints de rétrécissement mitral (maladie ventriculaire droite).

Un vecteur directionnel J très spécifique, dirigé en arrière et à droite dans le plan horizontal, est présent chez des malades ayant une rétrécissement mitral rhumatismales. Ce signe n'était pas présent chez des malades ayant une maladie ventriculaire gauche traitée par la Digoxine. La Digitaline ainsi facilite de manière significative le diagnostic électrocardiographique de maladie valvulaire mitrale rhumatismales, à travers son effet spécifique sur les événements de repolarisation, qui sont le mieux visibles dans les dérivations qui reflètent les variations de potentiel de la surface épicaudique du ventricule droit.

**Zusammenfassung**

Digitalisierung kann als Indikator einer Herzkammererkrankung nach Digoxin dienen. Der maximale T-Vektor war bei Hypertonie mehr nach vorne verlagert (linkss seitige Ventrikelerkrankung), während er bei Fällen von Mitralstenose (rechtsseitige Ventrikelerkrankung) dazu neigt nach hinten verlagert zu sein.

Einer spezifisch gerichteter J-Vektor, der in der horizontalen Ebene nach hinten und nach
rechts zeigte, war bei Patienten mit rheumatischer Mitralsstenose vorhanden. Dies zeigte sich nicht bei digitalisierten Patienten mit linkssitiger Ventrikelerkrankung. Digitalisierung fördert also deutlich die elektrocardiographische Diagnose von rheumatischen Mitralklappen-Erkrankungen durch ihre spezifische Wirkung auf die Repolarisation von Veränderungen, die am besten in den Ableitungen zu sehen sind, die die Potentialunterschiede der epikardialen Oberfläche der rechten Herzkammer widerspiegeln.

References
22 Unpublished observations.
23 Unpublished observations.

PULMONARY SCINTISSCANNING

The authors report their experience in performing more than 80 scintiscannings of 75 patients. They state that the scintiscanning generally corroborates the x-ray findings, but it is a useful adjunct in that it gives a quantitative idea of lung vascularization. The authors feel that scintiscanning is of little use in diagnosis of peripheral lesions of the lung or in early diagnosis of bronchogenic carcinoma.