

A rare sign of ischemia during exercise ECG: PR interval lengthening in the recovery period

Egzersiz EKG sırasında iskeminin nadir bir göstergesi: Toparlanma döneminde PR aralığı uzaması

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Summary– Exercise electrocardiography (ECG) is one of the most commonly utilized tests in cardiology. Despite the drawbacks, exercise ECG is widely preferred due to low cost, standardization, and strong prognostic information. A prolonged PR interval during recovery has recently been proposed as an indicator of mortality. Herein, we report an interesting case of a patient who presented with the complaint of exertional dyspnea and exhibited PR lengthening during the recovery period on the exercise ECG. The patient had a PR interval of 240 ms before exercise, which decreased to 160 ms at peak stress. However, during recovery, the PR interval prolonged gradually, reaching 320 ms at the second minute and persisting at that length until the end of the recovery period. The patient achieved 87% of the age predicted maximum heart rate, and experienced non-disabling shortness of breath and a pressure sensation in the chest, with no apparent ST segment depression. Recovery parameters, including heart rate recovery and systolic blood pressure recovery, were also within normal limits. The patient underwent coronary angiography with the suspicion of CAD which revealed severe multi-vessel disease. This rare case emphasizes the importance of PR lengthening in the recovery period as a sign of severe ischemia, in addition to other signs, such as prominent ST-segment changes, chronotropic incompetence, impaired hemodynamic response, and poor exercise capacity during stress ECG evaluation.

Özet– Egzersiz elektrokardiyografisi (EKG) kardiyoloji pratiğinde en yaygın kullanılan testlerden biridir. Egzersiz EKG'nin bazı dezavantajlarına rağmen düşük fiyatı, standardizasyonu ve güçlü prognostik değeri nedeniyle tercih edilen bir tanı yöntemidir. Toparlanma döneminde PR aralığında uzama son zamanlarda mortalitenin bir belirteci olarak bildirilmektedir. Bu yazıda, egzersiz dispnesi olan ve efor testinin dinlenme döneminde belirgin PR aralığı uzaması gelişen ilginç bir olgu sunuldu. Egzersiz öncesinde hastanın PR aralığı 240 ms idi, egzersizin en yüksek düzeyinde 160 ms'ye düştü. Toparlanma döneminde PR aralığı aşamalı olarak 320 ms'ye kadar uzadı ve dönemin sonuna kadar bu şekilde sürdü. Hasta ST-segmentinde belirgin bir çökme olmadan, göğüste sınırlayıcı olmayan bir baskı ve nefes darlığı ile yaşa göre hedef alınan maksimum kalp hızının %87'sine ulaştı. Kalp hızının toparlanması ve sistolik kan basıncının düzelmesini içeren dinlenme parametreleri normal sınırlar içerisindeydi. Hastaya koroner arter hastalığı şüphesi ile koroner anjiyografi yapıldı ve ciddi çokdamar hastalığı tanısı konuldu. Bu nadir olgu stres EKG değerlendirmesi sırasında zayıf egzersiz kapasitesi, bozulmuş hemodinamik yanıt, kronotropik yetersizlik ve belirgin ST-segment değişimine ek olarak ciddi iskeminin bir işareti olarak dinlenme aşamasında PR aralığı uzamasının önemini vurgulamaktadır.

Exercise electrocardiography (ECG) is a widely utilized diagnostic tool due to its low cost, standardized assessment of ischemia, functional capacity, and hemodynamic response. Recently, novel prognostic parameters, such as the Duke Treadmill Score

(DTS), heart rate recovery, and systolic blood pressure recovery, have garnered considerable interest, in addition to, well-known predictors: ST-segment changes, chronotropic incompetence, impaired hemodynamic response, and poor exercise capacity.^[1] Re-

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covery parameters, including abnormal heart rate recovery, systolic blood pressure recovery, and recurrent or high-grade ventricular ectopy, provide additional prognostic information, probably due to associations with autonomic dysfunction.^[2] Furthermore, an increasing number of abnormal non-ST parameters, including fitness, resting heart rate, chronotropic incompetence, and heart rate recovery, have been positively correlated with higher mortality rates.^[3] These results implicate the importance of recovery period and non-ST parameters in the evaluation of exercise ECGs.

Herein, we report the interesting case of a patient who demonstrated PR interval lengthening during the exercise ECG recovery period, a rare prognostic sign.

CASE REPORT

A 70-year-old male patient complaining of exertional dyspnea was admitted to the cardiology clinic at Rize University. The patient had quit smoking 10 years previously and had a 40 pack-year history of smoking, as well as, diabetes mellitus for two years. His current medications were aspirin and the oral anti-diabetic, metformin. His physical examination was normal except for hypertension (150/90 mmHg). His electrocardiogram (ECG) revealed a first degree atrioventricular (AV) block with a PR interval of 260 ms and delayed R wave progression in the precordial leads. Echocardiography demonstrated normal left ventricular systolic function and mild hypertrophy. Blood chemistry values normal, except for slightly

increased fasting glucose (173 mg/dl) and low-density cholesterol (131 mg/dl). According to current recommendations, the patient underwent exercise ECG using the standard Bruce protocol (Mortara Instrument, Inc., Milwaukee, USA) and achieved 87% of the age predicted maximum heart rate (APMHR) with a peak heart rate of 131 beats per minute and a work load of 5.5 metabolic equivalents (METS). He complained of non-disabling dyspnea and a pressure sensation in his chest but had no apparent ST-segment depression. His blood pressure values were 153/80 mmHg at the beginning, 230/90 mmHg at peak exercise, and 212/85 mmHg during recovery. Interestingly, his PR interval was 240 ms before exercise (Fig. 1) and shortened to 160 ms at peak stress. However, during recovery, the PR interval prolonged gradually up to 320 ms at the second minute and persisted at that length until the end of the recovery period (Table 1). The calculated DTS was 0, indicating an intermediate risk, and, therefore, a coronary angiography was performed. The coronary angiogram revealed severe multi-vessel disease: proximal total occlusion of the left anterior descending artery with good retrograde perfusion from collaterals of the circumflex artery, proximal stenosis of right coronary artery and stenosis of second obtuse margin artery (Fig. 2). The patient underwent coronary artery bypass graft surgery without complications during follow-up.

Abbreviations:

AV	Atrioventricular
ECG	Electrocardiography
DTS	Duke Treadmill Score

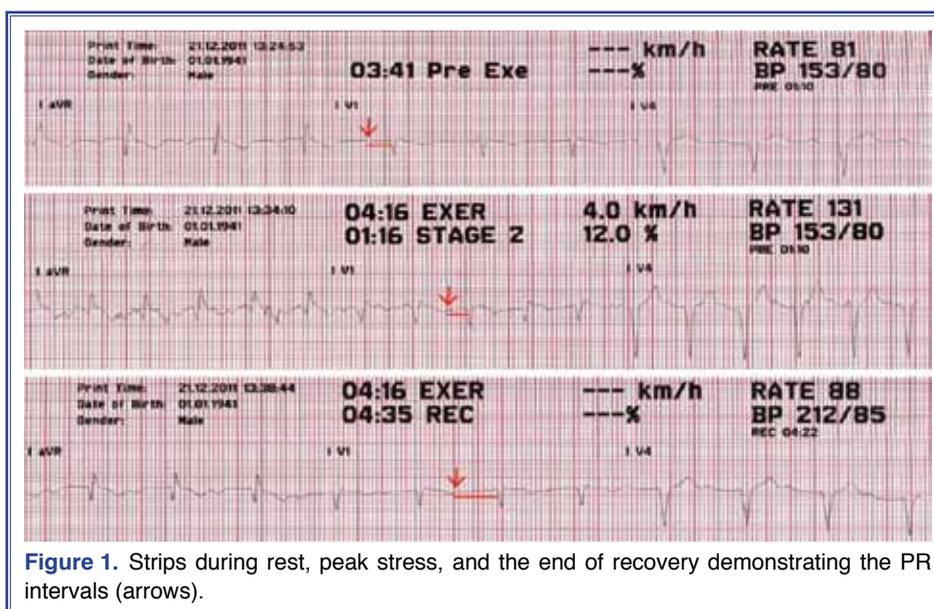


Figure 1. Strips during rest, peak stress, and the end of recovery demonstrating the PR intervals (arrows).

Table 1. Hemodynamic parameters and PR interval during exercise ECG

	At rest	Peak exercise	Recovery (1 min.)	Recovery (2 min.)
Heart rate (beats/min)	81	131	102	95
Blood pressure (mmHg)	153/80	230/90	212/85	190/80
PR interval (ms)	240	160	240	320

DISCUSSION

A first-degree AV block, or prolongation of the PR interval exceeding 200 ms, is a frequent finding in clinical practice. The prolongation of the PR interval is mainly due to decelerated conduction in the AV node or, less commonly, in the His-Purkinje system. Preliminary studies suggested that a first-degree AV block is an innocent finding.^[4] However, a recent study, from the Framingham Heart Study over 20 years follow-up, reported an increased risk of atrial fibrillation, pacemaker implantation, and all-cause mortality associated with first-degree AV blocks.^[5]

The PR interval shortens during exercise as a response to the increase in heart rate, which returns to normal values at rest. AV nodal conduction is controlled by both the extrinsic autonomic system and intrinsic mechanisms. Intrinsic modulation of AV nodal physiology does not have a significant effect at

rest, whereas during exercise, it maintains ventricular rhythm at a predetermined cycle length.^[6]

The PR interval during exercise ECG has recently been linked to cardiovascular mortality. PR intervals of 1979 patients enrolled in the Finnish cardiovascular study were measured at rest, and after one minute and two minutes of recovery. The pre-exercise PR interval was not prognostic after adjustment of cardiovascular risk factors; however, a prolonged AV interval at recovery was a significant predictor of mortality, both as a continuous variable and when categorized as ≥ 200 ms, over a four-year follow-up period.^[7]

Despite having a three vessel disease, our patient did not demonstrate classical markers associated with higher risk. The patient's recovery parameters were also normal. Only his DTS, a validated prognostic indicator of mortality, predicted an intermediate risk. Accordingly, the DTS seems to be more specific for detecting left main disease, three vessel disease, and

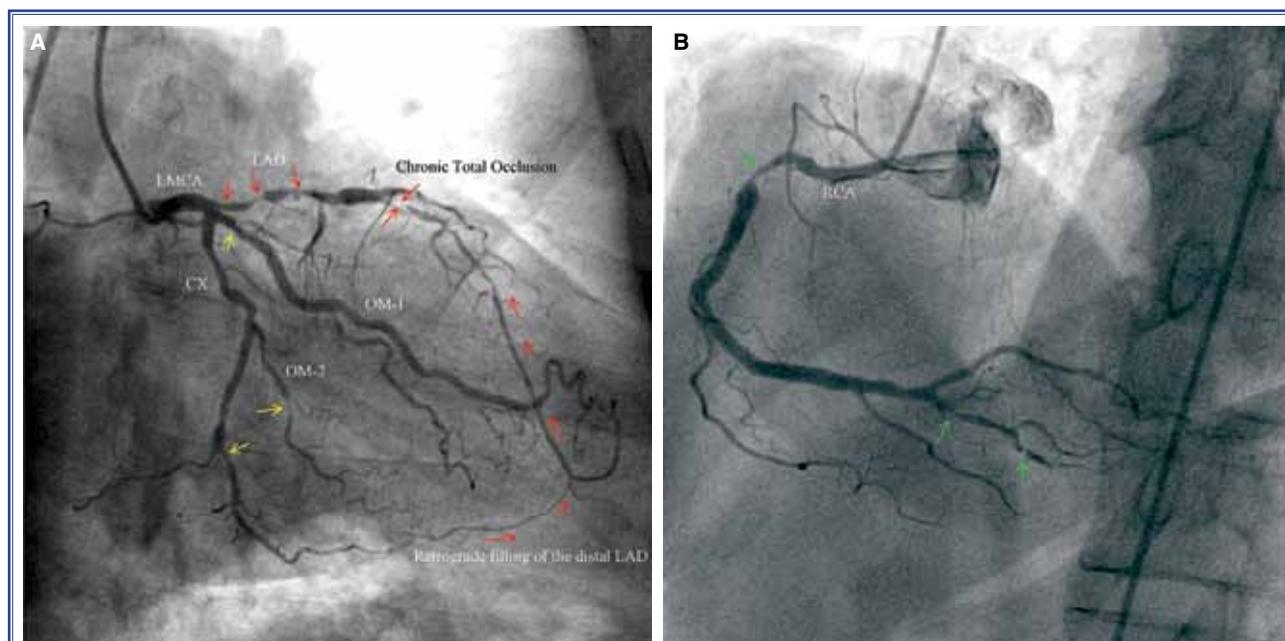


Figure 2. Still coronary angiography image from the patient demonstrating significant lesions in (A) the left and (B) right coronary arteries. LAD: Left anterior descending; LMCA: Left main coronary artery; Cx: Circumflex artery; OM1: First obtuse marginal branch; OM2: Second obtuse marginal branch; RCA: Right coronary artery.

two vessel disease involving the proximal left anterior descending artery.^[8] In addition, PR prolongation was the only abnormal parameter during recovery.

The cause of PR prolongation during exercise has not been previously clarified. We may speculate that significant ischemia, degeneration of conduction pathways, impaired intrinsic regulation of AV nodal physiology, and autonomic dysfunction may play a role. Regardless, this rare case emphasizes the importance of PR lengthening in the recovery period as a sign of severe ischemia, in addition to signs such as prominent ST segment changes, chronotropic incompetence, impaired hemodynamic response, and poor exercise capacity during stress ECG evaluation.

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Key words: Atrioventricular block; coronary artery disease; electrocardiography; exercise test; ischemia; heart function test.

Anahtar sözcükler: Atriyoventriküler blok; koroner arter hastalığı; elektrokardiyografi; egzersiz testi; iskemi; kalp işlev testi.