

Prediction of Early Reinitiation of Atrial Tachyarrhythmias Shortly After Successful Electrical Cardioversion

Ergün DEMİRALP, MD, Ata KIRILMAZ, MD, Fethi KILIÇASLAN, MD*, Kürşad ERİNÇ, MD**,
Eralp ULUSOY, MD, Namık ÖZMEN, MD, Bekir Sıtkı CEBECİ, MD, Mehmet DİNÇTÜRK, MD

Gülhane Military Medical Academy, Kadıköy - İstanbul, *Military Hospital, Department of Cardiology, Dışkapı - Ankara,
**Gülhane Military Medical Academy, Etlik - Ankara

Summary

This study was designed to assess the relationship between the early recurrence of atrial tachyarrhythmia (ERAT) and the pattern of the immediate atrial activities following electrical cardioversion (DC/ CVN). We tested the hypothesis that the early atrial activity pattern and time predicted ERAT.

We investigated clinical and electrocardiographic variables to predict ERAT in 20 minutes in randomly selected 123 procedures in 123 patients. Electrocardiograms recorded continuously were assessed for PP intervals and the type of atrial activity (sinus, atrial premature, fusion or junctional) for, at most, the first 35 beats following successful electrical cardioversion.

No-ERAT group consisted of 101 procedures in 101 patients (mean age 66 ± 13 years) without early recurrence of atrial tachyarrhythmia, whereas ERAT group ($n=22$) (mean age 69 ± 11 years) had recurrence within 20 minutes following successful DC/ CVN. There was no difference between groups regarding drugs received, including antiarrhythmics. Atrial tachyarrhythmia in the ERAT group recurred in 118 ± 280 seconds (3 sec-20 min). History of hypertension was significantly higher the in ERAT group. Increased pPP50 %, increased PAC/total beat ratio, and minimum PP interval have been found as predictors of ERAT in this study.

We concluded that history of hypertension was the only clinical harbinger of ERAT in 20 minutes following successful DC/ CVN. Frequent premature atrial activity with shorter coupling interval analyzed from surface ECG may identify a subgroup of patients who may benefit from immediate intervention to prevent from ERAT. Suppression of premature atrial activity during CVN may be a good target in preventing ERAT in this group of patients. (Türk Kardiyol Dern Arş 2004; 32: 246-251)

Key words: Atrial arrhythmia, DC cardioversion, early recurrence

Özet

Başarılı Elektriki Kardiyoversiyon Sonrası Erken Başlayan Atriyal Takiaritmilerin Öngörülmesi

Giriş: Bu çalışma atriyal takiaritmilerin erken nüksü (ATEN) ile elektriki kardiyoversiyondan (DC/ CVN) hemen sonraki atriyal aktivasyon arasındaki ilişkiyi değerlendirmek amacıyla düzenlendi. Erken atriyal aktivasyon paterni ile zamanının ATEN`nü öngöreceği hipotezi test edildi.

Metodlar: Çalışmada tesadüfi seçilmiş 123 hastada yapılan 123 DC/ CVN işleminden sonra ilk 20 dakika içinde ATEN`nün öngörülmesinde klinik ve elektrokardiyografik değişkenleri inceledik. Başarılı elektriki kardiyoversiyon süresince devamlı alınan EKG kayıtları üzerinden en az 35 atriyal atım olmak üzere atriyal aktivite tipi (sinus, atriyal erken vuru, füzyon veya kavşak atımı) ve PP aralıkları değerlendirildi.

Sonuçlar: ATEN izlenmeyen 101 hasta (ortalama yaş 66 ± 13 yıl) nüksüz grubu`nu oluştururken, nüks grubu`nda ise ($n=22$) (ortalama yaş 69 ± 11 yıl) başarılı DC/ CVN sonrası 20 dakika içinde ATEN izlendi. Nüks grubunda atriyal aritmi 118 ± 280 sn içinde (3 sn-20 dakika) nüks etti. Kullanılan antiaritmikler ve diğer ilaçlar

yönünden gruplar arasında fark yoktu. Nüks grubunda hipertansiyon sıklığı anlamlı olarak fazlaydı. Çalışmada yüksek pPP50 % değeri, artmış PAC/total atım oranı ve minimum PP intervali ATEN'nü öngörmekteydi.

Sonuç: Hipertansiyon hikayesi DC/CVN sonrası ilk 20 dakika içinde ATEN'in öngörülmesinde tek klinik belirleyici olarak saptandı. Yüzey EKG'sinden ölçülen "coupling" aralığı kısa sık erken atriyal aktivitenin varlığı, ATEN'ün önlenmesinde hızlı müdahaleden fayda görecektir bir grubu ortaya çıkarabilir. Bu grup hastalarda ATEN'ün önlenmesinde CVN esnasında erken atriyal aktivitenin baskılanması hedef alınabilir. (*Türk Kardiyol Dern Arş 2004; 32: 246-251*)

Anahtar kelimeler: Atriyal aritmi, erken rekürens, DC kardiyoversiyon

Early recurrence of atrial tachyarrhythmia (ERAT) has been observed after successful electrical cardioversion (DC/CVN) and represents a serious obstacle to the strategies for atrial rhythm control (1-9). Previous reports have revealed high incidence of ERAT (13-51%) depending on the definition of the early recurrence. Some known predictors of ERAT, such as coronary heart disease, advanced age, left atrial diameter > 60 mm, and duration of prevalent atrial tachyarrhythmia (AT), have been suggested from analyses of data compiled mainly from atrial/ventricular defibrillators, pacemakers or intracardiac atrial recordings (10). The per-patient incidences of ERAT were 44% in the first minute, 61% for the first hour and 70% for the first day in those patients with ERAT (11). These observations emphasized the importance of the early minutes in ERAT. This study has been designed to predict ERAT from the atrial activity patterns recorded in surface ECG immediately following cardioversion. Additionally, other clinical predictors of ERAT were also evaluated.

METHODS

Study population: One hundred twenty-three consecutive patients who were admitted to hospital and underwent successful electrical cardioversion (DC/CVN) for atrial tachyarrhythmia were included in the study. All patients had a baseline Doppler echocardiographic assessment, a full medical history, and physical and laboratory evaluation. The patients were connected to the ECG recorder for continuous recording of at least 6 leads during DC/CVN. The patients were monitored for 20 min-

utes to follow ERAT after successful cardioversion. Those patients with insufficient data were excluded. Thus 123 DC/CVN procedures in 123 patients were included in the study. The patients who have a recurrence of AT within the first 20 minutes following successful DC/CVN constituted the ERAT group. Those who do not have a recurrence of ERAT during 20 minutes of follow-up comprised No-ERAT group. Demographics, medications on board at the time of the cardioversion and echocardiographic parameters were analyzed to predict the ERAT. The patients were on appropriate anticoagulant therapy before and after cardioversion. Chronologically the first procedure was included in the study if more than one DC/CVN had been performed for the same patient. The patients with pacemakers were not included in the study.

Electrocardiographic parameters and definitions:

Following the proper preparation of the patients for DC/CVN, the electrocardiogram of at least 3 extremity leads recorded before, during and following DC/CVN in a continuous manner at standard amplification (1mV = 10 mm) and at a recording rate of 25 mm/sec by using a HP Pagemaster XLi ECG recorder (Hewlett-Packard, Andover, MA, USA). Analog outputs were then scanned in high resolution and electronic calipers were used for measurements. Two different investigators, who were blinded to the cases, analyzed all the ECG recordings. For each ECG recording, if a difference greater than 10% in any of the intervals measured by both investigators was found, the patient was not included. If the difference was less than 10%, both measurements were averaged.

DC shock delivery caused a baseline shift during which any kind of measurement could be impossible. This period was called "blank period". The atrial activation intervals following blank period was measured in ms and the atrial activation pattern was cate-

gorized as the following: (1) sinus beat if the activation pattern and axis of the atrial beat is the same with the sinus beat. Patients' previous ECGs in sinus rhythm were also evaluated for the morphology of sinus P wave when atrial pattern in ECG was in question (2) junctional beat if the P wave axis is superior and PR interval is short or if a ventricular activation caused a retrograde atrial activation (3) fusion beat if the axis of P wave is inferior and left but otherwise different from sinus beat P wave morphology (4) premature atrial beat if the axis of the P wave is different from the sinus P wave including junctional and fusion beat. The minimum recording time following the cardioversion needed for inclusion to the study was 5 seconds if ERAT does not happen before. The maximum number of the atrial activity analyzed was 35. In addition to the pattern of atrial activity, PP intervals were also analyzed for the following time domain parameters. (1) pPP50 % = Percentage of differences between adjacent PP intervals that are at least 50 ms; (2) SDPP = Standard deviation of PP intervals; (3) minimum PP interval; (4) PAC % = Percentage of the number of premature atrial contractions over total atrial beat.

Statistical analysis

Values of selected variables were summarized by standard descriptive statistics and expressed as mean ± SD. Clinical characteristics were summarized in terms of frequencies and percentages for categorical variables. Baseline characteristics were examined for statistical significance for continuous variables by a Student's t test or the Mann-Whitney U test. The Fisher's exact test was used for categorical variables. Statistical significance was defined by a p value < 0.05. The statistical package used was SPSS 11.0 for Windows.

RESULTS

Patient characteristics

One hundred twenty-three successful DC/CVN procedures in 123 patients (mean age of 67±13 years) were included in the study. Most of the patients were scheduled on DC/CVN on a semi-elective basis. The incidence of ERAT in the first 20 minutes was 18% and thus 22 patients constituted ERAT group. Ten patients developed ERAT in

11±6 sec (3-22 seconds) and the remaining 13 patients in 4±7 min. The remaining 101 patients comprised No-ERAT group.

The underlying atrial rhythm for CVN was atrial fibrillation (n=86), flutter (n=29), and atrial tachycardia (n=8) and the distribution between groups was similar. Etomidate (5%), Na-pentothal (65%) or propofol (10%) were used in discretion of anesthesiologist for the purpose of anesthesia. The average successful cardioversion energy was 240±90, 120±60 and 108±105 Joule for atrial fibrillation, atrial flutter and atrial tachycardia, respectively. The comparison of the baseline characteristics and demographics of the patients between groups were not different with the exception of hypertension (Table 1). Fifty and 35% of the patients were on antiarrhythmics in No-ERAT and ERAT group, respectively, at the time of DC/CVN. The majority of the patients on antiarrhythmics were on amiodarone (76% and 80% of the patients on in

Table 1. Comparison of the characteristics and demographics of the patients between groups

	No-ERAT group (n=101)	ERAT group (n=22)	P value
Number of AF/AFL/ATA	70/24/7	16/5/1	NS
Male/female	71/30	18/4	NS
Age	66±13	69±11	NS
Duration of AT (day)	44±56	68±79	0.17
Hypertension (%)	39	69	0.04
CAD (%)	42	47	NS
VHD (%)	31	9	0.06
MI in past (%)	21	20	NS
Diabetes mellitus (%)	12	20	NS
CRI/F (%)	12	13	NS
AAD (%)	50	35	0.26

AF/AFL/ATA: Atrial Fibrillation, Atrial Flutter, Atrial Tachycardia, CAD: Coronary Artery Disease, MI: Myocardial Infarction, VHD: Valvular Heart Disease, CRI/F: Chronic Renal Insufficiency or Failure, AAD: Antiarrhythmic Drug.

ERAT and No-ERAT group, respectively). The average amiodarone dosage was 180 ± 52 and 193 ± 63 mg/day in ERAT and No-ERAT groups, respectively. The duration of AT was slightly shorter in No-ERAT group, although it did not reach a significant level.

Electrocardiographic parameters

Following DC/CVN, there were blank periods of 1.2 ± 0.6 and 1.3 ± 0.7 sec in No-ERAT and ERAT groups, respectively. The first recorded atrial activity time was similar between groups. In No-ERAT group, the longest pause following DC/CVN was 14.6 sec, while in ERAT group it was 3.8 sec. Table 2 summarizes the comparison of the electrocardiographic parameters between groups. The most predictive of ERAT among electrocardiographic parameters was the percent of PACs following cardioversion. Although the standard deviation of PP intervals was not different between groups, pPP50 % was significantly higher in ERAT group. This was annealed by the significant short coupling inter-

val of PACs in ERAT group. The numbers of junctional and fusion beats were not different between groups.

DISCUSSION

This study demonstrates that analyses of surface electrocardiogram recorded peri-DC/CVN procedure can simply identify a subgroup of patients with a tendency to develop atrial tachyarrhythmia within 20 minutes. Although previous studies have demonstrated that patients having frequent PACs and PACs with short coupling intervals were prone to have an early relapse, such data mainly has derived from memory recordings of atrial/ventricular defibrillators, pacemakers or from intracardiac recordings during electrophysiological evaluation. Although the exact timing of PACs in our method is not superior to those of intracardiac recordings, precise pattern of atrial activity, whether sinus or PAC, can be accurately analyzed from surface ECG. A positive P wave in inferior leads was the hallmark of sinus beat in addition to the classical pattern in other leads. Furthermore, previous ECGs in sinus rhythm were also helpful.

The number of sinus beats in ERAT group was decreased. An explanation for this finding would lie in early recurrence of atrial arrhythmia so that there was no time for sinus beats counted. In contrary, total recording time and the number of atrial activity analyzed between groups were not different. Instead, frequent atrial activity was responsible for relatively decreased sinus node activity. Additionally, only 10 patients developed ERAT during recording of ECG in 11 ± 6 seconds (3-22 sec).

Increased pPP50 %, increased PAC/total beat ratio, and minimum PP interval have been found as predictors of

Table 2. Comparison of the electrocardiographic parameters between groups

Electrocardiographic parameters	No-ERAT group (n=101)	ERAT group (n=22)	P value
Average HR before CVN (bpm)	90±22	96±26	NS
Total recording time (sec)	19±9	20±9	NS
The number of atrial activation	21±9	20±9	NS
1st atrial activation time (msec)	1797±1483	1908±897	NS
SDPP (msec)	322±340	385±267	NS
pPP50 %	31±25	47±24	0.008
Number of junctional beats	2±3	2±2	NS
Number of fusion beats	1±1	1±2	NS
Number of premature atrial beats	5±6	8±8	0.12
Number of sinus beats	17±9	12±8	0.015
PAC/total beat (%)	20±21	36±29	0.003
Minimum PP interval (msec)	603±268	493±205	0.04

pPP50 % = Percentage of differences between adjacent PP intervals that are at least 50 ms, SDPP = Standard deviation of PP intervals.

ERAT in this study. More specifically, increased number and prematurity of the PACs just following the DC/CVN may predict recurrence of atrial tachyarrhythmia within 20 minutes following successful DC/CVN.

Several studies prompted the different definition of the early recurrence of atrial fibrillation. Yu et al. (2) reported the incidence of ERAT 1 min after DC/CVN as 26% among 50 patients. Daoud et al. (9) reported this incidence 5 min after cardioversion as 9% among 337 patients. The incidence of ERAF defined as AF recurrence within 5 min of conversion has been reported per-patient between 13% and 36% (4-7). No clinical or echocardiographic predictors were reported. Wellens et al. (8) demonstrated 27% per-episode and 51% per-patient incidences of ERAF (defined as AF recurrence within 1 min) among 41 patients implanted with the Metrix system (Model 3000 or 3020, Guidant Inc., St. Paul, Minnesota) who underwent cardioversion under direct physician observation. Although relatively long duration of AT and advanced age in our patient population would contribute a higher incidence, the short time course of ERAT limited to 20 minutes and different patient population might be responsible for an average incidence of 18%.

The history of hypertension was the only predictor of early recurrence of AT among demographics. Hypertension was the most common accompanied disease to AF and its prevalence was 40% (12). In our study, the prevalence of hypertension was 44% in all patients. On the other hand, the effects of acute hypertension on ERAT are missing in this study.

From the patient's perspective, ERAT within days may not be different. But ERAT can be cardioverted into sinus rhythm by DC/CVN while the patient was still under anesthesia if it occurs within minutes following DC/CVN. Consecutively, prediction of ERAT within 20 minutes may find clinical applications during DC/CVN. It may identify a subgroup of patients

who need to be started on antiarrhythmic medication in order to prevent from ERAT. A quick analysis of atrial activity in the surface ECG following DC/CVN may necessitate using antiarrhythmic medications to maintain sinus rhythm. There might have been a period early after AF onset during which remodeling was insubstantial and thus not a factor in determining susceptibility to AF (7). Sotalol and propafenone have been shown to reduce the incidence of ERAT when administered before DC/CVN (13). Although antiarrhythmic medications on board were higher in No-ERAT group, the difference was not statistically significant.

Conclusion

History of hypertension was the only clinical harbinger of ERAT in 20 minutes following successful DC/CVN. Frequent premature atrial activity with shorter coupling interval detected from surface ECG may identify a subgroup of patients who may benefit from immediate intervention to prevent from ERAT. Suppression of premature atrial activity during CVN may be a good target in preventing ERAT in this particular group of patients.

REFERENCES

1. Tieleman RG, Van Gelder IC, Crijns HJGM, et al: Early recurrences of atrial fibrillation after electrical cardioversion: a result of fibrillation induced electrical remodeling of the atria? *J Am Coll Cardiol* 1998; 31:167-73
2. Yu W-C, Lin Y-K, Tai C-T, et al: Early recurrence of atrial fibrillation after external cardioversion. *Pacing Clin Electrophysiol* 1999; 22:1614-9
3. Daoud EG, Hummel JD, Augustini R, et al: Effect of verapamil on immediate recurrence of atrial fibrillation. *J Cardiovasc Electrophysiol* 2000; 11:1231-7
4. Timmermans C, Rodriguez L-M, Smeets JLRM, et al: Immediate reinitiation of atrial fibrillation following internal atrial defibrillation. *J Cardiovasc Electrophysiol* 1998; 9:122-8
5. Tse H-F, Lau C-P, Ayers GM: Incidence and modes of onset of early reinitiation of atrial fibrillation after successful internal cardioversion, and its prevention by intravenous sotalol. *Heart* 1999; 82:319-24

6. Sra J, Biehl M, Blanck Z, et al: Spontaneous reinitiation of atrial fibrillation following transvenous atrial defibrillation. *Pacing Clin Electrophysiol* 1998; 21:1105-10
7. Tse H-F, Lau C-P, Ayers G: Atrial pacing for suppression of early reinitiation of atrial fibrillation after successful internal cardioversion. *Eur Heart J* 2000; 21:1167-76
8. Wellens HJJ, Lau C-P, Luderitz B, et al: Atrioverter: an implantable device for the treatment of atrial fibrillation. *Circulation* 1998; 98:1651-6
9. Daoud EG, Timmermans C, Fellows C, et al: Initial clinical experience with ambulatory use of an implantable atrial defibrillator for conversion of atrial fibrillation. *Circulation* 2000; 102:1407-13
10. Alt E, Ammer R, Lehmann G, et al: Patient characteristics and underlying heart disease as predictors of recurrent atrial fibrillation after internal and external cardioversion in patients treated with oral sotalol. *Am Heart J* 1997; 134:419-25
11. Schwartzman D, Musley SK, Swerdlow C, Hoyt RH, Warman EN: Early recurrence of atrial fibrillation after ambulatory Shock Conversion. *J Am Coll Cardiol* 2002; 40:93-9
12. Levy S, Maarek M, Coumel P, et al: Characterization of different subsets of atrial fibrillation in general practice in France: The ALFA study. *Circulation* 1999;99: 3028-35
13. Bianconi L, Mennuni M, Lukic V, Castro A, Chieffi M, Santini M: Effects of oral propafenone administration before electrical cardioversion of chronic atrial fibrillation: a placebo-controlled study. *JACC* 1996; 28:700-6