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Heart Electrical Instabilities: Some Mechanisms by Topology, Symmetry, Spin, Semiotics; Diagnosis

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Methods: We used algorithm for diagnosing heart electrical instability, which reduces to qualitative and quantitative analysis of electrocardiograms (ECG) in standard, inverted, 3D (as rotation bodies of ECG's elements) forms; constructing graphs, including "Gift wrapping" algorithm; calculation distances between points, angles between graphs, and others; comparison of qualitative and quantitative characteristics of these graphs by selective multiple testing; formulation of the diagnostic conclusion.

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HEARTELECTRICALINSTABILITIESSOMEMECHANISMSBYTOPOLOGYSYMMETRYSPINSEMIOTICSDIAGNOSIS

Strictly as per the compliance and regulations of:

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Results: We determinate disturbances of heart rhythm and conductivity components as unity of opposites, antonyms; oxymorons as result of fractal and/ or anti-fractal processes. Qualitative and quantitative characteristics of electrocardiograms in the patients with heart electrical instabilities, including pirouette ventricular pair extrasystoles, pirouette ventricular tachycardia, vicarious rhythms as result of sinus node dysfunction, binodal syndrome, gave us possibilities to determine peculiarities of oxymoron, fractal and anti-fractal, racemic Moebius strip like transitions and iteration.

Conclusion and Implications For Translation: Thus, our investigation give us possibilities to formulate models, algorithms for making heart electrical instability diagnosis by topology, symmetry, spin, semiotics of electromagnetic processes. Understanding electrical myocardial instability mechanisms improve the quality of diagnosis as precondition to treatment correction.

Keywords: heart electrical instability, mathematical modeling, diagnosis.

I. Introduction

a) Background of the Study

Different technologies were used for mathematical modeling of biological rhythms.[1,2] Heart electrical instability has various causes. Qualitative and quantitative electrocardiogram (ECG) assessment was basis for differential diagnosis[3-7].

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b) Objectives of the Study

Objects of investigation were 170 electro cardiograms with heart electrical instabilities.

c) Specific Aims

The purpose of this investigation was to formulate models, algorithms for making heart electrical instability diagnosis by topology, symmetry, spin, semiotics of electromagnetic processes.

II. Methods

a) Study Variables

Our concept is presented as step by step analysis of electrical myocardial instability.

We were used Typical Conceptual Spaces by some principles[8]:

- Information is organized by quality dimensions that are sorted into domains;
- Domains are endowed with a topology or metric;
- Similarity is represented by distance in a conceptual space.

Properties are presented a convex region in a single domain. Concept consists from number of convex regions in different domains and information about how the regions in different domains are correlated.[8] Concepts are equal frames and geometric structure.[8]

There are two properties of regions that are desirable: connectedness and convexity.[8] A region is connected if it cannot be decomposed into two or smaller nonintersecting regions.[8] It is convex if every line that connects any two points passes only through the region.[8] The notion of a line is contextual and, hence, so is that of convexity.[8]

We proposed oxymoron fractal and anti-fractal, and Moebius strip like heart arrhythmias and blockades, including racemic form concepts, that consist from such domains (regions) [9]:

Domain 1: Qualitative characteristics of ECG waves, segments, intervals (Types of ECG elements by forms as arcs, triangulates and others);

Domain 2: Quantitative characteristics of ECG waves, segments, intervals (Values of amplitudes, durations of ECG elements);

Domain 3: ECG elements and their origin (Heart morphological origins of ECG elements: sinus, atrioventicular nodes, conduction system and others);

Domain 4: Waves, segments, interval of ECG as bodies of rotation (3D geometry of ECG elements: ellipsoids, cones with their mirror reflections and others);

Domain 5: Spin direction of rotation waves, segments of ECG (Spin type direction of rotation ECG elements: superior or inferior, left or right);

Domain 6: Qualitative characteristics of "Gift wrapping" algorithm of ECG element analysis (The sequence of the connection ECG elements' as "Gift wrapping" [9]);

Domain 7: Quantitative characteristics of "Gift wrapping" algorithm of ECG element analysis (Values of surface, volume characteristics of ECG elements "Gift wrapping"[9] and distances between points, angles of polygons);

Domain 8: Fractal characteristics of ECG elements (Types of ECG elements fractal characteristics as Cantor, Koch, Sierpinski sets and others);

Domain 9: Anti-fractal characteristics of ECG elements (Types of ECG elements anti-fractal characteristics as anti-snowflake Koch and others).

Antonym, oxymoron concept is presented as analysis of electrical myocardial instability as[11]:

- Initiation of myocardial electrical instability in concrete case;
- Determination of arrhythmic and blockade types;
- Searching of disturbance heart rhythm and conductivity components as unity of opposites, antonyms;
- Selection of basic and additional antonym pairs;
- Conversion of these results as fractal and/ or anti-fractal antonyms;
- Presentation of data as graphical models by Dragon language. [10]

Conversion of cardiac arrhythmias and blockades as fractal and/ or anti-fractal antonyms by genetic algorithm promote understanding of arrhythmogenesis, triggers and resonators of these processes; improve the quality of diagnosis as precondition to correct treatment.

Genetic algorithm of heart electrical instabilities diagnosis by fractal and anti-fractal analysis [11]:

- We take a pairs of chromosomes, consisting from fractals and/ or anti-fractals.
- Chromosome genes may be sets and anti-sets: Cantor, Julia, Mandelbrot, von Koch, Sierpinski carpet, Sierpinski Triangle, Sierpinski anti-Triangle, the Sierpinski gasket, the Sierpinski anti-gasket, Peano curve, Peano anti-curve, the Hilbert curve, Darer pentagon, Cantor square, tricorn and multicorns.
- As a result of crossing-over (one-, two-point or multi-point), we get new offspring chromosomes consisting from different combinations of genes.
- New chromosomes allow to analyze physical, mathematical, biomedical data.
- Results of modeling of cardiac arrhythmias and blockades as the unity of opposites, fractal and anti-fractal antonyms, oxymorons is presented on language "Dragon".[10]

We used the quantum genetic algorithm for differential diagnosis of antonym, oxymoron like heart electrical instabilities by using of qubit chromosomes.[12]

Pecularities of Moebius strip like cardiac arrhythmias and blockages were determined by convex analysis according to such scheme[9]:

- initialization of cardiac electrical instability as a Moebius strip by peculiarities of atrial and ventricular depolarization and repolarization;
- convex analysis by type, volume, surface bodies of rotation electrocardiograms elements;
- convex analysis by joining of PQSRT – PQSRT complexes points according to "Gift wrapping" algorithm"[9];
- construction of the convex hull for determination the relationship between the investigated complexes as Moebius strip like constituents;
- making conclusions by using of conceptual spaces data.

b) Statistical Analysis

We used of algorithm of creative solutions as derivatives of selective multiple testing[13]:

i. *Initial selection of multiple testing methods;*

A1: Selection of independent and dependent variability; Calculating the of mean, standard error of mean, standard deviation, 95% confidence interval for mean, median, minimum, maximum, range, quartiles;

Determination of the variabilities distribution - parametric or nonparametric by single-factor the Kolmogorov-Smirnov test; Shapiro-Wilk W test and graphical methods: frequency distribution histograms stem & leaf plots; scatter plots; box & whisker plots; normal probability plots: PP and QQ plots; graphs with error bars (Graphs: Error Bar).

A2: ANOVA (Analysis of Variance) test is used for parametric variabilities distribution. If deviations are homogeneous by Levene test would used the method of multiple comparison groups by Tukey HSD, Scheffe, Bonferroni, and in the cases without homogeneity we must use the criteria Tamhane's T2, Games-Howell; Kruskal-Wallis test, nonparametric equivalent of the ANOVA, is used for nonparametric variabilities distribution;

A3: The selection of variabilities, as criteria for making decisions, with P = .05 or less, and / or minimal false discovery rate, q-value. Determination of the sensitivity and specificity of these variabilities.

ii. *Secondary screening the variabilities for multiple test methods*

B1: These numerical dependent variabilities with P = .05 or less, and / or minimal false discovery rate, with high sensitivity and specificity by diagnostic capabilities must use for formation of new variabilities as descendants of 2, 3, 4.. n numerical dependent variabilities as the derivatives of various mathematical transformations as Cantor, Sierpinski, von Koch sets, etc., anti-fractal sets; Moebius strip like aggregates, oxymoron combinations; and others mathematical transformations derivatives.

iii. *Check the newly formed variabilities similar to step A to estimate the effectiveness of such changes.*

iv. *Comparison of multiple testing of more informative primary and secondary variabilities by accuracy, sensitivity and specificity of diagnostic possibilities.*

v. *If it's necessary, the search of new selection principles of variabilities for multiple testing must be continued.*

c) Ethical Approval

Complaince with Ethical Standards

III. Results

Examples of linear and nonlinear antonym pathogenesis of arrhythmias and blockades as result of unity[11]:

- Sinus node dysfunction as sinoatrial blockade II stage and atrial fibrillation;
- Sinus node dysfunction as tachy-brady-syndrome–bradycardia may originate in the sinus, atria, atrioventricular junction, or ventricle; the tachycardia is usually caused by atrial flutter or fibrillation, although it can also be caused, albeit less commonly, by reentrant supraventricular tachycardia in the sinus node or atrial muscle;
- Binodal syndrome as: Sinus node dysfunction-sinus bradycardia, alternating bradycardia and atrial tachyarrhythmias (bradycardia- tachycardia syndrome), sinus pause or arrest, and sinoatrial (SA) exit block. Various supraventricular tachyarrhythmias, such as atrial fibrillation and atrial flutter. Trifascicular Block-Right Bundle Branch Block (BBBB) with Both Left anterior fascicular block (LAFB) and Left posterior fascicular block (LPFB) give AV III block.
- Both Left anterior fascicular block (LAFB) and Left posterior fascicular block (LPFB) equal Left Bundle Branch Block (LBBB);

Example of the quantum genetic algorithm using for differential diagnosis of antonym, oxymoron like heart electrical instabilities for sinus node dysfunction syndrome or binodal syndrome by some qubit chrosomes:

$|q\rangle = \alpha 1|0\rangle + \alpha 2|1\rangle$

$|q1\rangle = \alpha 1$ (sinoatrial blockade II stage) $|0\rangle + \alpha 2$ (atrial fibrillation) $|1\rangle$

$|q2\rangle = \alpha 1$ (tachy- brady- syndrome) $|0\rangle\ \alpha 2$ (atrial flutter) $|1\rangle$

$|q3\rangle = \alpha 1$(re-entrant supraventricular tachycardia) $|0\rangle + \alpha 2$ (Trifascicular Block - Right Bundle Branch Block with Both Left anterior fascicular block and Left posterior fascicular block) $|1\rangle$

$|q4\rangle = \alpha 1$ (Atrioventricular III block) $|0\rangle + \alpha 2$ (atrial fibrillation) $|1\rangle$

$|q5\rangle = \alpha 1$ (sinus bradycardia)$|0\rangle + \alpha 2$ (atrial tachyarrhythmias) $|1\rangle$

$|q6\rangle = \alpha 1$ (sinus pause) $|0\rangle + \alpha 2$ (atrial fibrillation) $|1\rangle$

$|q7\rangle = \alpha 1$ (sinoatrial exit block) $|0\rangle + \alpha 2$ (sinus bradycardia) $|1\rangle$

Some examples of linear and nonlinear antonym pathogenesis of arrhythmias and blockades as result of unity [11]:

- Both Left and Right Bundle Branch Block (BBBB);
- Bifascicular Block - Right Bundle Branch Block (BBBB) with Left anterior fascicular block (LAFB);
- Bifascicular Block - Right Bundle Branch Block (BBBB) with Left posterior fascicular block (LPFB);
- Pair racemic, pirouette ventricular extrasystoles as sum of LVE (left ventricular extrasystole) and RVE (right ventricular extrasystole);

Rhythm and conduction disturbances can be represented by various known fractal- antifractal structural, electrical remodelling of the heart (fig. 1).[11] So Sierpinski napkin may reflect small and large sclerotic sclerotic processes in the myocardium, as a result of chronic and acute forms of coronary artery disease. [11] At the same time, this kind of fractal and Cantor set may reflect multiple foci of atrial depolarization during atrial fibrillation. Koch set may be a prototype, model of CLC, WPW syndromes; left, right bundle branch blockades. [11] Tricorn and multicorns antifractals can be a model of the pathogenesis of rhythm and conduction disorders, as a re-entry effect. [11] Examples of oxymoron pathogenesis of arrhythmias[11]:

The Moebius like space orientation of depolarization processes were characterized by the change of supraventricular pacemaker and ectopic activity onto the ventricular one.[11]

In the patients with sick sinus syndrome, the Moebius like arrhythmias were displayed as a combination of supraventricular and ventricular extrasystoles, pair fibrillation and flutter transformation from atria to ventricles.[11]

Qualitative and quantitative characteristics of 2D, 3D electrocardiograms in the patients with pirouette ventricular pair extrasystoles, pirouette ventricular tachycardia, vicarious rhythms as result of sinus node dysfunction, binodal syndrome gave us possibilities to determine peculiarities of oxymoron, fractal and antifractal, racemic Moebius strip like transitions and iteration (fig. 2,3).[14,15]

IV. Discussion

The proposed technology of solving clinical problems by system and anti-system comparison, presented as a graphical model and program by languages "Dragon", promotes understanding of complex principles of clinical medicine, improve the quality of diagnosis as precondition to change of the treatment.[11] Electrical instability of the heart is derived from its structural and electrical remodeling.[11] Rhythm and conduction disturbances can be represented by various known fractals and anti-fractals.[11]

Characteristics of volume, surface, laminar and turbulent data, spin, chirality of rotation bodies of electrocardiogram elements give us possibilities to determine depolarization and repolarization electro-magnetic picture, oxymoron, fractal and anti-fractal, Moebius strip like transitions and iteration, state of electrical heart instabilities.[11]

V. Conclusion and Implications for Translation

Our investigation give us possibilities to formulate models, algorithms for making heart electrical instability diagnosis by topology, symmetry, spin, semiotics of electromagnetic processes.

Understanding electrical myocardial instability mechanisms improve the quality of diagnosis as precondition to treatment correction.

Compliance with Ethical Standards

Conflicts of Interest: Author state that there are no conflicts of interest to report. The work done by the author, there is no fund received from any agency or company at all.

Financial Disclosure: The work done by the author, there is no fund received from any agency or company at all.

Ethics Approval: Complaince with Ethical Standards

Key Messages

Understanding electrical myocardial instability mechanisms improve the quality of diagnosis as precondition to treatment correction.

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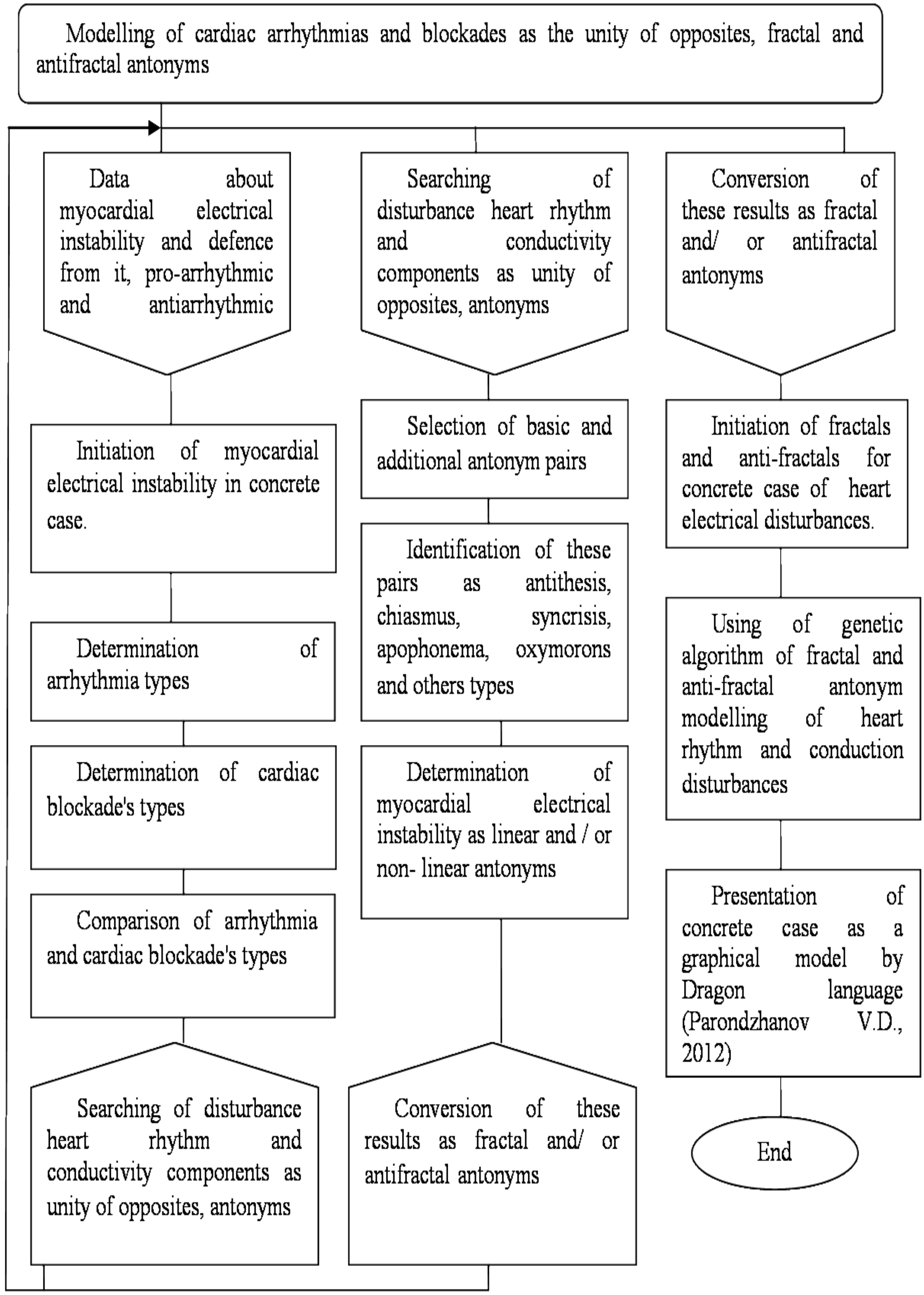

Fig. 1: Modelling of cardiac arrhythmias and blockades as the unity of opposites, fractal and antifractal antonyms[11]

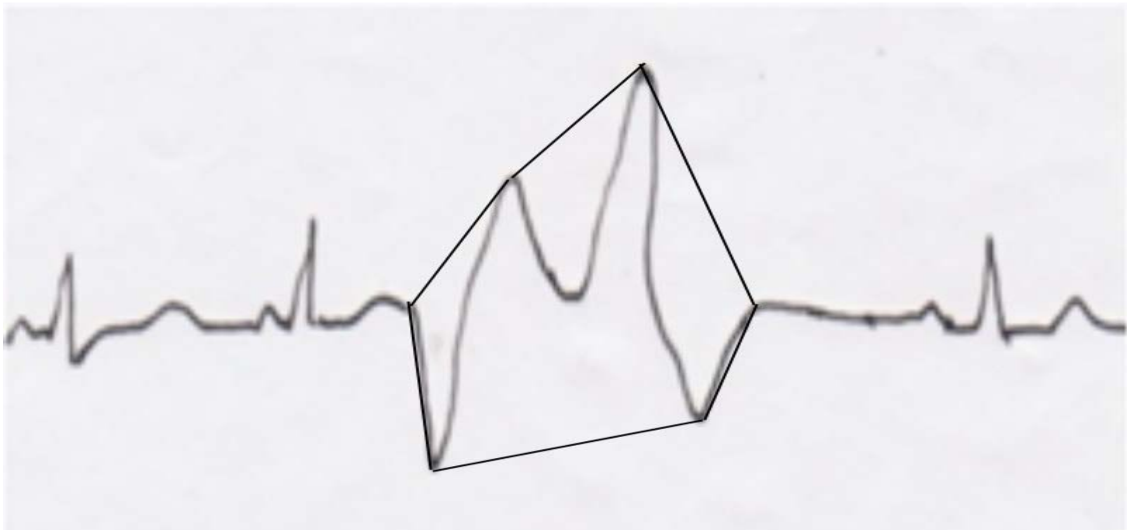

Fig. 2: The convex hull of ECG complexes as Moebius strip like constituents in the patients with pair pirouette ventricular premature beats.[15]

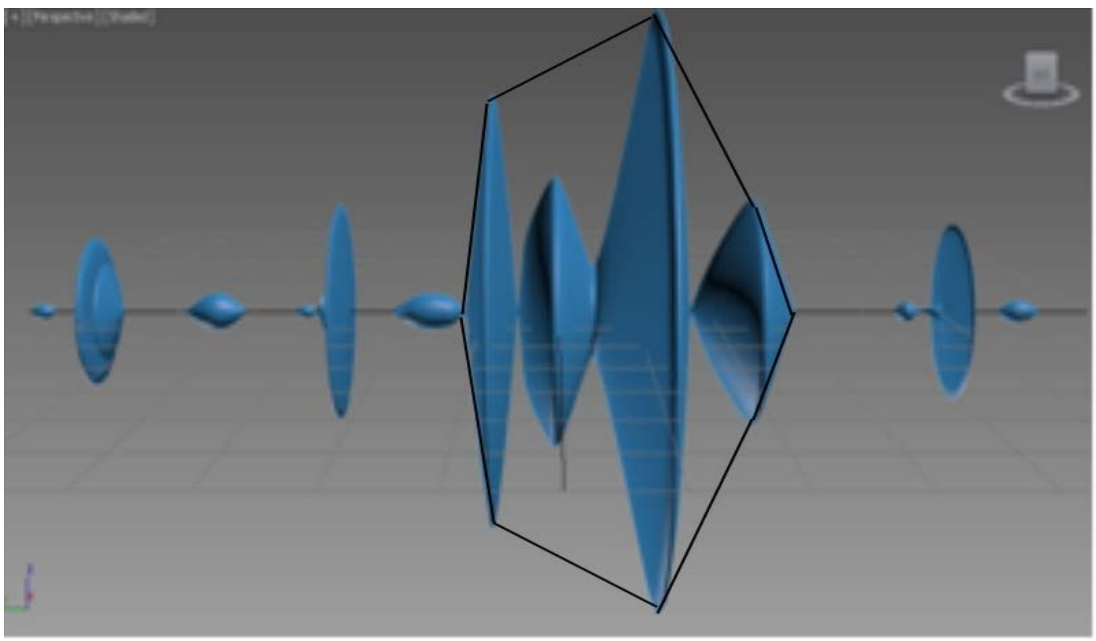

Fig. 3: The convex hull of rotation bodies of electrocardiogram elements complexes as Moebius strip like constituents in the patients with pair pirouette ventricular premature beats.[15]