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Initial experience with zero or near zero-fluoroscopy to perform catheter ablation of supraventricular tachycardias in a private practice setting

Experiencia inicial para la realización de ablaciones con catéter de taquicardias supraventriculares sin fluoroscopia, o casi 0-fluoroscopia en una práctica privada

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Keywords:
zero-fluoroscopy, radiofrequency ablation, atrioventricular node reentry, supraventricular tachycardia, electro-anatomical mapping.

Palabras clave:
cero-fluoroscopia, ablación por radiofrecuencia, reentrada nodal, taquicardia supraventricular, mapeo electro-anatómico.

ABSTRACT

Introduction: fluoroscopy has been the main navigation tool in electrophysiology for decades, but it has inherent risks to both patients and the medical team. Zero-fluoroscopy systems have been used for several years now and they show a safer profile, although their costs are of concern. **Material and methods:** in 2022, we collected information about patients selected for electrophysiological study and supraventricular arrhythmia ablation in our group in central Mexico City and presented them as a series of cases. **Results:** ten patients were treated without fluoroscopy or with minimal radiation exposure during the year. They were mostly young (43.6 ± 20.8 years old) female subjects (80%). The mean procedure duration time was 118 ± 17.1 minutes. There were no immediate complications, and all the procedures were successful regarding the elimination of the arrhythmia substrate. **Conclusions:** this is a small series of patients representing an initial approach in our community to introduce 0-F procedures with good results and within safe limits for patients and the medical team.

RESUMEN

Introducción: *la fluoroscopia ha sido la herramienta de navegación empleada en electrofisiología por décadas, sin embargo, tiene riesgos inherentes para el paciente y el equipo médico. Los sistemas de cero-fluoroscopia se han usado desde hace varios años y han mostrado ser seguros, aunque los costos deben considerarse.* ***Material y métodos:*** *durante 2022 se recopilaron los datos de pacientes consecutivos sometidos a estudio electrofisiológico y ablación por arritmias supraventriculares en una ciudad del centro de la República Mexicana. Se presentan los datos como una serie de casos.* ***Resultados:*** *durante el año se trataron 10 pacientes sin fluoroscopia o con una exposición mínima a radiación. Fueron predominantemente mujeres (80%) jóvenes (43.6 ± 20.8 años). El tiempo promedio de duración del procedimiento fue de 118 ± 17.1 minutos. No hubo complicaciones inmediatas y se logró la eliminación del sustrato arrítmico en todos los casos.* ***Conclusiones:*** *esta es una pequeña serie de pacientes que representa la experiencia inicial en nuestra comunidad para introducir procedimientos de 0-fluoroscopia con buenos resultados y seguridad tanto para el paciente como para el equipo sanitario.*

INTRODUCTION

Interventional electrophysiologic procedures have increased both in frequency and complexity. Fluoroscopy has been the main imaging technique to perform intracardiac catheter navigation for a long time. Nonetheless, it has deterministic risks (dose-related) as skin lesions and stochastic risks (dose-independent) as increased neoplasia risk and genetic damage.[1,2]

Those deleterious effects from radiation are worrisome in obese subjects, young persons or patients that will receive long, complex or

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repeated procedures. On the other hand, the medical team (operators, nurses, technicians) is exposed on a daily or nearly daily basis to significant ionizing radiation doses that increase the risk of cancer, cataract and congenital defects, especially in high volume centers and even with the use of protective personal equipment, that in some instances (such as in low volume centers) is not always available or is suboptimal.[2-4] In Mexico, many facilities outside large medical centers do not have enough personal protection equipment or do not totally comply with the «Reglamento general de seguridad radiológica»;[5] although this is a non-published observation.

New navigation technologies without fluoroscopy, which also allow obtaining electro-anatomic intracardiac maps, significantly reduce radiation exposure during diagnostic and therapeutic-ablation procedures, even in complex cases.[4,6-11] The ALARA principle «As low as reasonably achievable» to reduce as much as possible ionizing radiation exposure is an old recommendation of the American College of Cardiology[12] that remains paramount for safety.

Several studies have shown that procedures without fluoroscopy are safe and effective, with a relatively fast learning curve and they show a significant reduction in radiation exposure for the patient and the medical team.[13,14] This was the reason to start a zero-fluoroscopy (0-F) or «near-zero fluoroscopy» program in our group. We ought to evaluate its viability in a private practice setting of a middle size city (1,049,777 inhabitants according to the 2020 national census) and present here an initial series of cases of patients submitted for electrophysiologic study and ablation for different arrhythmias.

MATERIAL AND METHODS

A descriptive study was performed. Data were prospectively collected from consecutive cases referred for supraventricular tachy-arrhythmia ablation from January 2022 to December 2022. A meeting before the intervention was devoted to explain the technique to the patients and their nests of kin, the expected benefits and the risk of complications of the procedure. After their doubts were answered, all patients signed an informed consent according to the hospital's policies. The patient's confidentiality was respected and no individual data was revealed to or used by other parties. All patients had medical insurance so that expensive electroanatomic mapping systems could be used. Complex cases (Atrial fibrillation, ventricular premature beats, atrial tachycardias) were performed with electro-anatomical mapping systems (Biosense Webster CARTO© or Abbott EnSite©), but we did not discard a priori fluoroscopy use. The analysis is mainly based on subjects with atrio-ventricular reentry through accessory pathways and atrio-ventricular node reentry tachycardia since these are less complex arrhythmias to treat and more suitable to gain experience.

We included demographic, initial and final electrophysiologic data, use or not of fluoroscopy, procedure time-length and location of the successful ablation site. Recurrences during the follow-up period in 2022 were also recorded.

In every patient an individualized clinical review was performed, as well as an electrocardiogram (ECG) analysis in sinus rhythm and, when available, with the symptomatic tachycardia (either 12-lead ECG or Holter monitoring tracing). According to this evaluation, we planned the vascular access, usually beginning with right femoral vein punctures (two or three) guided by ultrasound under local anesthesia. If needed, we inserted a femoral artery catheter (usually the ablation catheter) to reach left side accessory pathways, also with ultrasound guidance.

We routinely placed a decapolar catheter in the coronary sinus and a tetrapolar catheter in the atrio-ventricular node area to identify a His bundle potential. The EnSite mapping system depicts the vascular trajectory from the iliac vein to the superior vena cava and cardiac chambers. We performed an initial diagnostic electrophysiologic (EP) study during which we measured conduction intervals, atrial and ventricular refractory periods and antegrade and retrograde Wenckebach points. A decapolar coronary sinus catheter and a tetrapolar right atrial catheter were inserted for that purpose. Both were the initial mapping tools to reconstruct the intracardiac

anatomy. If the arrhythmia was induced with these maneuvers, we interrupted it by stimulation (entrainment, extrastimuli, or override pacing). Once the baseline study was finished and the diagnosis was established, the radiofrequency (RF) ablation catheter was introduced (either by venous or arterial approach), and we searched for the best ablation site with the electroanatomical mapping functions, as well as the conventional signal recording of the catheter to the polygraph. We used irrigated catheters to apply RF, and once the responsible structure was eliminated, we did a new tachycardia induction protocol. In all cases, we used radiofrequency as the energy source, and the RF generator was adjusted according to the area to be ablated by temperature, impedance and power. If the ablation was successful, we waited for 20 to 30 minutes to repeat the induction protocol, and if the absence of arrhythmia was corroborated, we concluded the procedure and catheters and introducers were withdrawn. In every case, there were adaptations to the technique based on anatomical and functional characteristics that would be too long to depict here, and it is not the objective of this presentation.

Statistical analysis

Categorical variables are expressed in total and percent values. Continuous variables are shown in averages ± standard deviation. We did a comparison between the initial and final electrophysiological variables of the study using a paired T-test for the continuous variables.

RESULTS

During 2022 we performed 28 electrophysiologic studies and ablations. We present ten consecutive cases of supraventricular tachycardia treated without fluoroscopy or with near-0 fluoroscopy. There were seven female patients (80%), and the group's average age was 43.6 ± 20.8 years. The mean procedure time in the group was 118 ± 17.1 minutes, including the described waiting period after ablation to ensure a lack of immediate recurrence. The mean fluoroscopy time was 1.2 ± 2.1 seconds for the whole group, but as seen in *Table 1*, fluoroscopy was only used in three patients to ensure the femoral introducers' guidewire position or, in one case, evaluate the fluoroscopic aspect of a coronary sinus catheter. The shortest X-ray exposure was two

Table 1: General description of the cases. N = 10.

Case number	Age (years)	Gender	Arrhythmia	Procedure duration (min)	Fluoros duration (seg)	Mapping system	Venous accesses	Arterial accesses	Radio frequency duration (min)	Successful ablation
1	53	Female	AVNRT	150	0	Ensite	2	0	2.54	Yes
2	48	Female	AVNRT	140	0	Ensite	2	0	2	Yes
3	34	Female	AVNRT	120	0	Ensite	3	0	2.5	Yes
4	81	Female	AVNRT	120	0	Ensite	3	0	2.5	Yes
5	68	Female	AVNRT	130	0	Ensite	3	0	3	Yes
6	15	Male	AVRT right PS	90	5	Ensite	3	0	2	Yes
7	14	Male	AVRT left post	140	0	Ensite	3	1	2	Yes
8	40	Female	AVRT left lateral	120	5	Ensite	3	1	2.5	Yes
9	45	Female	AVNRT	110	2	Ensite	3	0	2	Yes
10	38	Male	AVRT left antero-lateral	60	0	Ensite	2	1	3	Yes

AVNRT = atrio-ventricular node re-entry tachycardia. AVRT = atrio-ventricular re-entry tachycardia. PS = postero-septal. Post = posterior. Lat = lateral.

Table 2: Electrophysiologic parameters.

Electrophysiologic parameter	Pre-ablation	Post-ablation	p
Atrium-his interval (AH)	68.13 ± 16.49	65.43 ± 17.8	0.33
His-ventricle interval (HV)	46.1 ± 14.7	51.6 ± 6.52	0.39
Anterograde Wenckebach point (PWA)	341.25 ± 82.3	330 ± 42.4	0.25
Retrograde Wenckebach point (PWR)	313.3 ± 73.03	432 ± 113.9	0.301

The projection is a right anterior oblique, almost in a lateral position, as can be seen in the tracking image in the superior right corner of the image.

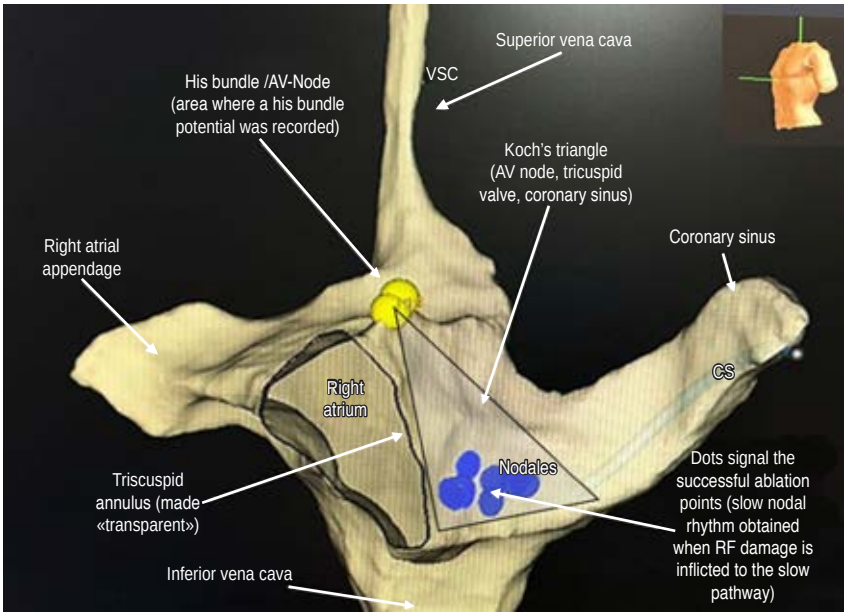

Figure 1:

Cartographic location of the slow pathway in an atrioventricular node reentrant tachycardia.

seconds, and the longest was five seconds. All the vascular accesses were performed under vascular ultrasound guidance.

In one patient, we had to do an electro-anatomic «remap» because the electrogram signals obtained by the intracardiac catheter were not accurately concordant with the position of the catheter in the represented electroanatomic map.

If a fast nodal rhythm appeared during RF administration, for example, in the case of a slow nodal pathway ablation, RF was immediately stopped and the ablation catheter was repositioned to a safer zone, more distal to the His bundle area-electrogram. The same happened with a postero-septal accessory pathway. This is why the main number of RF pulses was not included; instead, we recorded the total RF time.

Table 1 shows the main characteristics of the patients. Six had atrio-ventricular node reentry tachycardia, and 4 had atrio-ventricular reentry through an accessory pathway. *Table 2* shows the electrophysiologic parameters before and after ablation. The main cycle length of the AVNRT was 287.5 ± 41.1 ms, and for the accessory pathways (AVRT), it was 309.6 ± 60.25 ms. *Figure 1* shows a common cartographic map of Koch's triangle, the area suitable for the ablation of a slow conduction pathway in the case of a patient with AVNRT.

In all the patients submitted to ablation with the present protocol, there was a successful

elimination of the arrhythmia in the acute setting, and during follow-up (that went from 11 months to one month) there were no recurrences in the treated patients, nor chronic complications. We had no acute complications during the procedures, and since the vascular approach was performed under ultrasound guidance, there was only one patient with a minimum hematoma in the puncture site that did not require further treatment prior to his discharge the following day after the cardiac ablation procedure.

DISCUSSION

Electrophysiology procedures without fluoroscopy have become a safe and doable option in many places in the world. To the health team in charge of doing them, reducing ionizing radiation exposure has significant advantages. A study by Marazziti et al.[15] in 2015 found that interventional cardiologists have a high risk of presenting problems ranging from neuropsychological deterioration of cognitive functions related to the left hemisphere to brain neoplasia and orthopedic lesions. So, a reduction of exposure may limit those problems. Patients also show benefits from reduced radiation exposure, as mentioned in the introduction.[1,2] When initiating zero or near-zero fluoroscopy interventions, starting with «simple» substrates located in the right cavities is recommended: reentrant tachycardia in the atrioventricular node or common atrial flutter for example. We did not include flutter, instead, we ablated accessory pathways. In order to gain confidence, large centers suggest that radiological protection can be worn, and the position of the catheters obtained from the navigator and electroanatomical mapping can be confirmed with conventional fluoroscopy. In our cases, the few seconds of fluoroscopy were mostly used to confirm a guidewire position in the venous or arterial position next to the puncture site.

Once enough confidence has been obtained, the use of radiation protection garments could be discontinued to achieve another advantage of the Zero-Fluoroscopy procedure: avoid spinal injuries. The next step is to gradually increase the number and complexity of the arrhythmic substrates to be treated.

In this series of cases, there were more female subjects. Chen et al.[16] observed a higher prevalence of women in the 0-F group, as in another study with fewer patients,[17] but as the number of subjects included is higher, that appreciation loses its significance. We are aware that there is a selection bias in our series due to the higher proportion of young women of fertile age that were included. This difference might be reduced as more patients are included in the future.

Several studies have demonstrated that there are no significant differences in the success rate of different tachycardias ablation with any of both approaches.[2,13,17-20] None of the patients in this series had structural heart damage, a fact that helps in the overall positive success rate, as showed in the study by Kawakami et al.[21] They made extensive use of intracardiac echocardiography (ICE) and ultrasound-guided venous and atrial septal puncture (transesophageal echo), thereby obtaining a reduction in intervention-related complications. In the present cases, no further ultrasound support was required.

There were no significant differences in the EP parameters before and after the procedure. This finding suggests that the technique is as safe as the conventional approach and somehow reinforces the concept that it is not associated with higher complication rates, as has been found in similar work with 14 patients by Robledo et al.[22] The precise location of anatomical structures such as the atrio-ventricular node in an electroanatomic map might reduce the risk of damage with RF.

Prolic et al.[18] showed a longer duration of the ablation procedures when performed without fluoroscopy, but Chen et al.,[16] found that the difference between fluoroscopy-guided and 0-F procedures disappeared as the team acquired more experience with the navigation systems. This fact is usually attributed to the learning curve of the operators.[13,19,23]

Limitations

This article is a descriptive case series study. Even if the data collection was prospective

and in consecutive patients, the navigation method choice was biased by the kind of patient, gender, age and the arrhythmia diagnosed by a 12-lead ECG. As we gather more experience, the probability to produce comparative results between a 0-F group and a conventional one, with different types of arrhythmias will be higher. Nonetheless, even while complying with the ALARA principle, complex arrhythmias might require a combined approach (fluoroscopy-electroanatomic mapping) to achieve successful results.

The number of patients is another limitation, partly explained by the intervention costs, the selection mode and the frequency at which EP procedures can be performed out of a specialized center.

CONCLUSIONS

The present study shows that a 0-F program is feasible in a private practice setting in a medium size city, although the time to reach a considerable volume of patients might be longer than desired. Our results are comparable to the findings of others and suggest that these 0-F or near 0-F ablations are achievable within safe limits for the patients and the medical team.

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