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Interatrial blocks in patients with TAVI and their associations with clinic parameters

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ABSTRACT

Aims: The present study attempted to evaluate the prevalence of basal interatrial blocks (IABs), their associations with clinical parameters, and the interatrial conduction in the follow-up after a successful transcatheter aortic valve implantation (TAVI) procedure among patients with severe aortic stenosis.

Methods: We retrospectively evaluated the findings of 90 patients undergoing TAVI in our center. Overall, we considered the presence and grades of IABs and P-wave durations in electrocardiograms (ECG), preoperative echocardiography (ECHO) findings (maximum and mean gradients and left atrium (LA) diameter), valve size and type, and changes in these parameters at sixth month.

Results: Forty-six patients were included in the study which are suitable for the pre-determined inclusion criteria. We found the mean age of the patients to be 74.78±8.66 years. In preoperatively-evaluated ECGs, while we detected partial IABs in 37% of the patients, there were advanced IABs in 6.5%, but 56.5% yielded no interatrial conduction disorder. On the other hand, in postoperatively-evaluated ECGs, while we observed partial IABs in 30.4% of the patients, there were advanced IABs among 21.7% (p=0.017). Nevertheless, we could not conclude any IABs among 47.8% of the patients. Besides, 54.3% of the patients received a self-expandable valve, and a balloon-expandable valve was inserted in 45.7%. In this regard, we detected partial (7 patients) and advanced (2 patients) IABs in the preoperatively-evaluated ECGs of the patients receiving a self-expandable valve. In the postoperative ECGs of these patients, while the partial IAB remained the same in 4 patients (57.1%), it progressed to an advanced IAB in 3 (42.9%). In addition, while the advanced IAB regressed to a partial IAB in one patient, it remained the same for the other patient. In this group, the mean P-wave durations were found to be 118.4±22.67 before the TAVI and 119.6±21.69 after the TAVI (p=0.113). In the preoperative ECGs of 21 patients with a balloon-expandable valve, we detected partial IABs in 10 patients and an advanced IAB in one patient. While a partial IAB developed in five patients (p=0.022), five patients with a partial IAB developed an advanced IAB following the procedure (p=0.022). In this group, we noticed a significant difference between preoperative (127.62±19.4) and postoperative (138.71±32.03) P-wave durations (p=0.038).

Conclusion: In a nutshell, we concluded no significant change in interatrial conduction time of the patients with TAVI compared to the baseline in their sixth-month ECGs. When considered by valve type, we concluded that the development and progression of IABs were significant among those with a balloon-expandable valve. The higher postoperative mean gradient among those with a balloon-expandable valve compared to those with a self-expandable valve may be associated with significantly longer P-wave duration among those with a balloon-expandable valve.

Keywords: TAVI, interatrial block, balloon-expandable valve, P-wave duration

INTRODUCTION

Symptomatic severe aortic stenosis (AS) has become a seminal health problem due to the increased older adult population. AS is now definitely treated with aortic valve replacement (AVR). However, it may be rather challenging to decide on conservative follow-up or surgical treatment in patients at high risk regarding surgery. Occurring particularly among older adults with comorbidities, this situation has led to the improvement of percutaneous intervention techniques with a lower procedure risk than operative techniques.

The percutaneous AVR procedure was first introduced in animal studies in the early 1990s, and Cribier et al.[1] performed the first human application of the procedure in 2002. The procedure, called transcatheter aortic valve implantation (TAVI), may be one of the most exciting developments in interventional cardiology in the last 15 years. Thanks to the promising findings of the research, TAVI has been boosted with significant technological advancements and is now widely adopted worldwide. In many centers, it is adopted as a standard treatment technique for patients with high surgical risk or who cannot be recruited for any operation.

An interatrial block (IAB) is an electrical conduction defect between the right and left atria and is defined as a P-wave duration over 120 milliseconds (ms) in a standard 12-lead surface electrocardiographic (ECG) examination (**Figure 1**).[2]

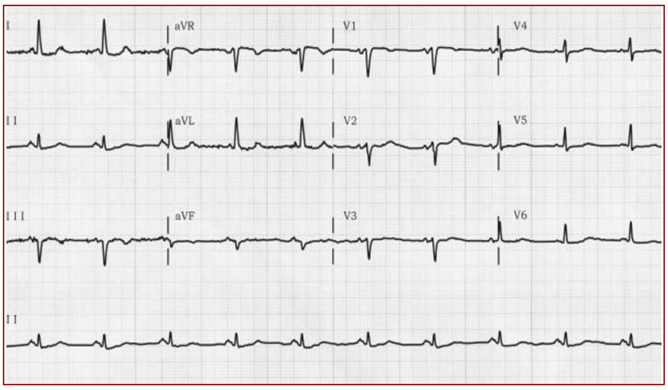

Figure 1. An Example of IAB in ECG

ECG demonstrates the presence of an IAB; the P-wave duration is broad (>110 ms) and bifid. An IAB can be graded as partial or advanced[3,4] ; the distinction is based on P-wave duration and, more apparently, on P-wave morphology. A bifid P-wave (notched P-wave) in leads I, II, III, and aVF is thought to represent a partial IAB.[5] It was previously demonstrated that the negative deflection phase in the P-wave morphology in lead V1 in a partial IAB is less pronounced than in the negative P-wave in left atrial enlargement (LAE).[6] Biphasic P waves (± P-waves) in the inferior leads (II, III, and aVF) of an advanced IAB usually indicate cauda-cranial left atrial activation due to a fixed block in the normal conduction pathway (**Figure 2**).

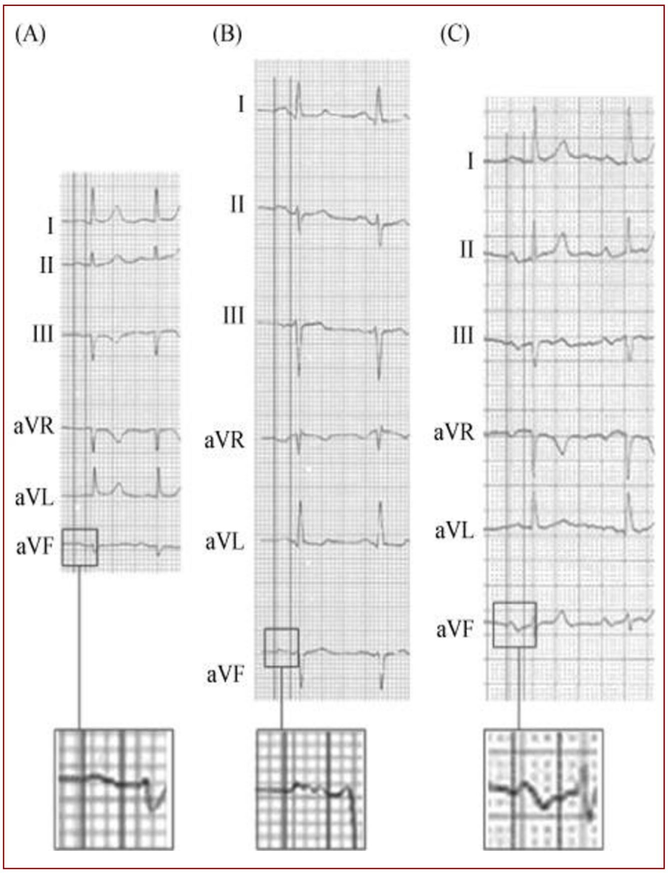

Figure 2. Grading of IABs. (A) normal P-wave, (B) P-wave of a partial IAB, and (C) P-wave of an advanced IAB.

An IAB may be a primary or causal risk factor for various atrial arrhythmias (particularly atrial fibrillation (AF)) and may also be associated with a variety of other clinical abnormalities, such as thromboembolism, including left atrial dilatation, embolic stroke, mesenteric ischemia.[7]

In their study, Lourdes et al.[8] investigated the preoperative prevalence of IABs and postoperative mortality in TAVI and found that 53% of 1,842 patients did not have interatrial conduction defects, but 31% had a partial IAB and 16% an advanced IAB. In conclusion, the advanced IAB emerged as an indicator of mortality regardless of all causes. A multicenter registry study on the prevalence of IABs, permanent pacemaker insertion, and their relationships with new-onset amnesia and stroke was launched in Spain in 2019 but has not yet been concluded.[9] In this study, we considered the presence and grades of IABs and P-wave duration in electrocardiograms (ECG), pre-procedural echocardiography (ECHO) findings (maximum and mean gradients and left atrium (LA) diameter), valve size and type, and changes in parameters at sixth month. To our knowledge, this is the pioneering study in the literature to address valve types and their effects on interatrial conduction.

METHODS

Sample

The Non-Interventional Researches Ethics Committee of Gaziantep University granted ethical approval to our study (Date: 12/04/2019, Decision No.: 2019/450). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. In the study, we retrospectively evaluated the preoperative ECGs of 90 patients undergoing a TAVI and successfully discharged between 2015 and 2020 in the Department of Cardiology of Gaziantep University Sahinbey Training and Research Hospital. However, we excluded 44 patients without archive records, with preoperative and postoperative AF, and without preoperative ECHO data. Then, we retrospectively examined the patients' ECG and ECHO findings at the time of diagnosis, after the procedure at hospitalization, and at the sixth-month follow-up. In the subsequent sections, the patients' demographic characteristics and procedural characteristics are presented.

Preoperative Evaluation

ECG, transthoracic echocardiography (TTE), transesophageal echocardiography (TEE), coronary and peripheral angiography, and multislice computed tomography (CT) were routinely performed in all patients with an indication/scheduled for TAVI. We extracted relevant data from the database of our hospital and patient files.

Echocardiographic Evaluation

In this study, the echocardiographic parameters were obtained by a specialist, experienced in the echocardiographic evaluation, by using the GE Healthcare Vivid S6 1-5 MHz transducer in our echocardiography laboratory. In accordance with the latest guidelines of the American Society of Echocardiography (ASE), color tissue Doppler images of the posterior wall (from the parasternal long axis), the septal and lateral walls (from the apical 4-chamber position), and the anterior and inferior walls (from the apical 2-chamber position) were obtained from the patients. Aortic VTI and maximal and mean gradients were taken with CW-Doppler on the aortic valve from the apical 5-chamber position. Finally, left ventricular outflow tract (LVOT) VTI was taken with PW-Doppler on the LVOT. The LVOT diameter was measured from the parasternal long axis at the junction of the septum of the aortic valve and the anterior leaflet of the mitral valve. Interventricular septum (IVS), posterior wall (PW), left ventricular diastolic diameter (LVDD), left ventricular systolic diameter (LVSD), and left ventricular ejection fraction (LVEF) were calculated from the MMOD section at the level of the LV papillary muscle. All measurements were performed by considering the mean values of three consecutive cycles. Finally, the aortic valve area was calculated according to the following formula: (LVOT diameter)2×0.785×(LVOT TVI)/(Aortic valve TVI).

Procedural Characteristics

The procedure was performed under fluoroscopy with local anesthesia, as well as general anesthesia in some selected patients. Prior to the procedure, the patients were given 300 mg clopidogrel, 300 mg acetylsalicylic acid, and 2 g cefazolin. Those with chronic renal disease or at high risk of developing contrast-related renal injury were administered intravenous hydration before and after the procedure. The cardiology team applied deep and standard incision and percutaneous intervention to 90 patients. Following balloon predilatation of the native aortic valve, CoreValve/CoreValve Evolut R (CoreValve Revalving Technology, Medtronic, Minneapolis, Minnesota), Edwards SAPIEN 3 or Edwards SAPIEN XT (Edwards Lifesciences, Irvine, California), St. Jude Medical Portico Valve (St. Jude Medical, St. Paul, Minnesota), and Boston Scientific bioprosthetic valve (Boston Scientific, Marlborough, MA) were inserted under burst pacing of the right ventricle. Postdilatation was applied to the cases that were thought to be insufficiently dilated. The team chose the type of intervention, valve model, and other materials based on their preferences and experience.

Statistical Analysis

We tested if the data showed a normal distribution using the Shapiro-Wilk test. While we performed independent pair-wise comparisons of the non-normally distributed data with the Mann-Whitney U test, we utilized the Wilcoxon signed-rank test for comparisons of the related samples. The analysis of the ordered categorical variables at two different times was performed with the McNemar-Bowker test. Moreover, we calculated Spearman's rank correlation coefficients to test the relationships between continuous variables. We performed all statistical analyses on the SPSS 22.0 program and accepted a p-value < 0.05 to be statistically significant.

RESULTS

In this study, we considered the data of 46 patients undergoing TAVI between 2015 and 2020 and satisfying our inclusion criteria. The mean age of the patients, 28 (60.9%) females and 18 (39.1%) males, was found to be 74.78±8.66 years. Their mean left atrium diameter was 41±4.39 mm, while the mean valve size used in the procedures was 26.43±2.69 mm. The mean preoperative and postoperative P-wave durations were calculated to be 122.61±21.52 ms 128.31±28.3 ms. Moreover, the preoperative and postoperative maximum gradients were discovered to be 84±20.35 mm/Hg and 21.5±9.69 mm/Hg, respectively. Finally, the preoperative and postoperative mean gradients were 52.85±13.39 mm/Hg and 11.5±5.78 mm/Hg, respectively (**Table 1**).

Table 1. Descriptive statistics

Parameters	M±SD
Age	74.78±8.66
Valve size (mm)	26.43±2.69
Preoperative P-wave Duration (ms)	122.61±21.52
Preoperative Max. Gradient (mmHg)	84±20.35
Preoperative Mean Gradient (mmHg)	52.85±13.39
Postoperative P-wave Duration (ms)	128.31±28.3
Postoperative Max Gradient (mmHg)	21.5±9.69
Postoperative Mean Gradient (mmHg)	11.5±5.78
LA diameter (mm)	41±4.39

In preoperatively-evaluated ECGs, while we detected partial IABs in 17 patients (37%), there were advanced IABs in 3 patients (6.5%), but 26 patients (56.5%) yielded no interatrial conduction disorder. On the other hand, in postoperatively-evaluated ECGs, while we observed partial IABs in 14 patients (30.4%), there were advanced IABs among 10 patients (21.7%). Nevertheless, we could not conclude any IABs among 22 patients (47.8%). Therefore, the patients did not significantly differ by the presence of an IAB (p=0.017; **Table 2**). The postoperative findings of 26 patients without an IAB in their preoperative evaluation yielded that five patients (19.2%) developed a partial IAB, but 21 (80.8%) did not have any interatrial conduction defects (p=0.017). Given the postoperative findings of 17 patients (37%) with a partial IAB in their preoperative evaluation, we discovered that the partial IAB persisted in 8 patients (47.1%), progressed to an advanced IAB in 8 patients (47.1%), and disappeared in one patient (5.9%) (p=0.017). Finally, the postoperative evaluation of 3 (6.5%) patients with an advanced IAB in their preoperative assessment showed that it regressed to a partial IAB in 1 (33.3%) patient but persisted in the other two (66.6%) (p=0.017).

Table 2. Comparison of IABs in preoperative and postoperative ECGs

Preoperative ECG	Postoperative ECG			p
	No IAB	Partial IAB	Advanced IAB	
	n (%)	n (%)	n (%)	
No IAB	21(80.8)	5(19.2)	0(0)	0.017
Partial IAB	1(5.9)	8(47.1)	8(47.1)	
Advanced IAB	0 (0)	1(33.3)	2(66.7)	

*p < 0.05, ECG: Electrocardiography

The mean postoperative P-wave duration of the patients (128.31±28.3 ms) did not significantly differ from their mean preoperative P-wave duration (122.61±21.52 ms; p=0.095). However, the patients' preoperative maximum and mean gradient values (84±20.35 mm/Hg and 52.85±13.39 mm/Hg) were significantly higher than their postoperative results (21.5±9.69 mm/Hg and 11.5±5.78 mm/Hg, respectively) (p=0.001 for both; **Table 3**).

Table 3. Preoperative and postoperative electrocardiographic and echocardiographic parameters

Parameters	Patients n (46)	
Preoperative P-wave Duration (ms)	122.61±21.52	p=0.095
Postoperative P-wave Duration (ms)	128.31±28.3	
Preoperative Max. Gradient	84±20.35	p=0.001
Postoperative Max. Gradient	21.5±9.69	
Preoperative Mean Gradient	52.85±13.39	p=0.001
Preoperative Mean Gradient	11.5±5.78	

*p < 0.05, ms: millisecond

While 25 patients (54.3%) received a self-expandable valve, it was the balloon-expandable valve in 21 patients (45.7%). The preoperative ECG findings of 25 patients with a self-expandable valve showed that 16 had no IAB, 7 had a partial IAB, and 2 had an advanced IAB. Regarding their postoperative ECG findings, we discovered that 16 patients still had no IAB. While the partial IAB was protected in 4 (57.1%) of 7 patients, it progressed to an advanced IAB in 3 patients (42.9%). Finally, the advanced IAB regressed to a partial IAB in one patient but was protected in the other.

The preoperative ECG findings of 21 patients with a balloon-expandable valve showed that ten patients had no IAB, ten patients had a partial IAB, and one had an advanced IAB. The postoperative ECG findings of these patients demonstrated that five patients still had no IAB, while the other five developed a partial IAB (p=0.022). The partial IAB of 4 patients (40%) remained the same, disappeared in 1 (10%), and progressed to an advanced IAB in 5 patients (50%) (p=0.022). The advanced IAB remained the same in one patient (**Table 4**).

Table 4. Distribution of preoperative and postoperative IABs by valve type

	Postoperative ECG			
	No IAB	Partial IAB	Advanced IAB	p
	n(%)	n(%)	n(%)	
Self-expandable Preoperative ECG				0.317
No IAB	16(100)	0(0)	0(0)	
Partial IAB	0(0)	4(57.1)	3(42.9)	
Advanced IAB	0(0)	1(50)	1(50)	
Balloon-expandable Preoperative ECG				0.022
No IAB	5(50)	5(50)	0(0)	
Partial IAB	1(10)	4(40)	5(50)	
Advanced IAB	0(0)	0(0)	1(100)	

p < 0.05, ECG: Electrocardiography

We discovered no significant difference between the mean preoperative (118.4±22.67 ms) and postoperative (119.6±21.69 ms) P-wave durations of 25 patients with a self-expandable valve (p=0.113). Nevertheless, we concluded a significant difference between the mean preoperative (127.62±19.4 ms) and postoperative (138.71±32.03 ms) P-wave durations of 21 patients with a balloon-expandable valve (p=0.038). There were no significant differences between the patients with self- and balloon-expandable valves by preoperative and postoperative maximum gradients (82.56± 22.35 mm/Hg vs. 85.71± 18.07 mm/Hg and 19.2±5.97 mm/Hg vs. 24.24±12.41 mm/Hg, respectively; p=0.174). It was also the case between the patient groups by mean gradients (52.76±13.6 mm/Hg vs. 52.95±13.47 mm/Hg and 9.92±3.86 mm/Hg vs. 13.38±7.1 mm/Hg, respectively; p=0.068) (**Table 5**).

Table 5. Comparison of P-wave durations and gradients by valve type

Variables	Self-expandable (n=25)	Balon-expandable (n=21)	p
Preoperative P-wave Duration (ms)	118.4±22.67	127.62±19.4	0.113
Postoperative P-wave Duration (ms)	119.6±21.69	138.71±32.03	0.038
Preoperative Max. Gradient (mmHg)	82.56±22.35	85.71±18.07	0.439
Postoperative Max. Gradient (mmHg)	19.2±5.97	24.24±12.41	0.174
Preoperative Mean Gradient (mmHg)	52.76±13.6	52.95±13.47	0.833
Postoperative Mean Gradient (mmHg)	9.92±3.86	13.38±7.1	0.068

p < 0.05, ECG: Electrocardiography

DISCUSSION

An IAB may be associated with a variety of other clinical abnormalities for various atrial arrhythmias (particularly AF), such as thromboembolism, including prior stroke and mesenteric ischemia. Unfortunately, scholarly efforts, as well as physicians, are still deprived of sufficient data to hinder and treat IABs. The questions of if there are factors predicting arrhythmias in patients with an IAB and whether anticoagulants should be started before arrhythmia remain covered. IABs deserve more scholarly attention; thus, further research is highly needed to reach a consensus on appropriate management strategies. An IAB is an anomaly prevalently detected in the general population and among older adults undergoing a TAVI and can be quickly diagnosed with the help of ECGs. Previously, it was found to be associated with significant endpoints such as AF, ischemic stroke, and mesenteric embolism. Carrillo-Loza et al.[10] showed it to have a robust predictive property in predicting recurrent stroke in strokes of unknown origin.

Left atrial dilatation causes disturbances in impulse conduction in the atrium, where P-wave duration is prolonged, and AF develops in advanced cases. Escobar-Robledo et al. demonstrated that an advanced IAB is linked with an elevated risk of stroke in patients with heart failure. O'Neal et al.[11] revealed that the incidence rate of ischemic stroke among patients with an advanced IAB is twice that of those without.

In their study, Cotter et al.[12] evaluated the incidence of AF in patients with loop recorder implantation to assess for unexplained stroke. They found the incidence of AF to be 25.5% and concluded IABs to be significantly more prevalent in patients with AF compared to those without. In another study, Cotter et al.[13] evaluated younger patients (< 55 years) with cryptogenic stroke and found that young patients with unexplained stroke had more prolonged P-wave durations and a higher prevalence of IABs.

In a study by Enriquez et al.[14] the presence of an IAB was found to be the highest risk factor for AF after atrial flutter ablation.

Çinier et al.[15] proposed IABs are prevalent in patients with STEMI and associated with the presence of diffuse coronary artery disease and new onset of AF. In our study, we focused on the presence of preoperative and postoperative (sixth month) IABs, their grades, and their associations with TAVI-related factors among older adults with TAVI procedure.

We first considered the data of 90 patients undergoing TAVI between 2015-2020 and included the data of 46 who met our inclusion criteria. We excluded 25 patients with AF in their preoperative ECGs, 10 patients without the follow-up ECG findings, and 11 patients with AF rhythm in the sixth-month follow-up.

Due to the high prevalence of IABs reported in previous research on their epidemiology, the presence of IABs has sometimes been called a "pandemic." In a study with older adults with sinus rhythm, the prevalence of IABs was found to be 49% in patients aged > 65 years. In our study, the mean age of the patients was 74.78±8.66 years, and 43.5% had an IAB. We found that the presence of an IAB increased to 51.5% following the TAVI procedure. Particularly, the development of an advanced IAB increased among the patients. While present in three patients before the procedure, it was observed in ten patients after the procedure. Besides, despite prolonged P-wave duration after the TAVI, it was not statistically significant. When comparing the patients with self- and balloon-expandable valves, the P-wave durations of those in the latter group were prolonged after the procedure. In addition, postoperative mean gradients were found to be higher in patients with a balloon-expandable valve than the others. There were no significant differences in the development of an IAB before and after the procedure and its transition from partial to advanced in patients with a self-expandable valve, but we discovered that while a partial IAB developed in half of the patients with a balloon-expandable valve who initially did not have interatrial conduction defects, the initial partial IAB in the other half progressed to an advanced IAB. The postoperative mean gradient was found to be higher among those with a balloon-expandable valve compared to the patients with a self-expandable valve. In general, we considered that increased left ventricular diastolic pressure may be reflected in the left atrium, contributing to the development of an IAB.

The small sample size and the single-center, retrospective design may be counted among the limitations of our study. However, it should be noted that we were able to reach the data of a significant number of patients in our country and that it is a pioneering study on this subject.

CONCLUSION

Overall, IABs are prevalent in patients with severe aortic stenosis scheduled for a TAVI. We concluded no significant change in the interatrial conduction time in the sixth-month ECG findings of patients undergoing a TAVI compared to their baseline findings. Considering the patients by valve type, we discovered that the development and progression of an IAB were significant in those with a balloon-expandable valve. Finally, we think that the higher postoperative mean gradients in the patients with a balloon-expandable valve compared to the others may be related to the significantly longer P-wave duration in these patients..

ETHICAL DECLARATIONS

Ethics Committee Approval: The Non-Interventional Researches Ethics Committee of Gaziantep University granted ethical approval to our study (Date: 12/04/2019, Decision No: 2019/450).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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