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Catheter ablation of accessory pathway: 14-year trends in utilization and complications in adults in the United States

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ABSTRACT

Background: The aim of this study was to determine the temporal trends in utilization of catheter ablation of accessory pathways in the United States.
Methods: All patients from the Nationwide Inpatient Sample (NIS) ≥18 years of age with a primary diagnosis of anomalous atrioventricular excitation syndrome (*International Classification of Diseases, Ninth Edition, Clinical Modification* [ICD-9-CM] code 426.7) were included in the study. Patients who underwent catheter ablation were identified using ICD-9-CM procedure code 37.34. Patients with a concomitant diagnosis of atrial fibrillation, atrial flutter, atrial tachycardia or ventricular arrhythmias were excluded from the analysis. Annual hospital volume was identified using unique hospital identification number and was divided into tertiles for further analysis.
Results: A total of 11,601 catheter ablations for anomalous atrioventricular excitation syndrome were studied from 1998 to 2011. The mean length of stay was 1.8 days (median 1 day). The utilization trends of accessory pathway ablation have steadily declined from 3.9 ablation procedures/million US population in 1998–1999 to 2.5 ablation procedures/million US population in 2010–2011. The second tertile (adjusted OR 0.41; 95% CI 0.20–0.83, p = 0.01) and third tertile (adjusted OR 0.39; 95% CI 0.18–0.85, p = 0.02) of hospital volume were associated with reduction in cardiac complications as compared to first tertile of hospital volume. Advanced age (OR 1.02, 95% CI 1.01–1.04, p = 0.002) was independent predictor of cardiac complications. There were no in-hospital deaths.
Conclusion: Despite decline in ablation trends, it still remains a relatively safe procedure associated with low morbidity and no mortality.

1. Introduction

The exact prevalence of accessory pathways associated with patient symptoms, also known as Wolff-Parkinson White (WPW) syndrome, is unknown but it is estimated to be between 0.068 and 0.17% [1]. A short refractory period of the accessory pathway may allow fast conduction to the ventricles resulting in rapid ventricular response. This could degenerate in ventricular fibrillation and cause sudden cardiac death with an estimated risk around 0.15% per patient-year [2,3]. In a prospective trial among an Italian pediatric population, the risk of life threatening tachycardia was 2.18% per patient-year and sudden cardiac death was estimated around 0.34% per patient-year [4].

It is estimated that approximately 65% of the patients with accessory pathway detected on the resting ECG are asymptomatic [5]. Also, since majority of patients do not have episodes of atrial fibrillation and/or paroxysmal supraventricular tachycardia, guidelines recommend catheter ablation as a Class I recommendation only for symptomatic patients (controversial in case of asymptomatic patients) [5].

The era of catheter ablation for the treatment of arrhythmias began in 1981 with the first atrioventricular junction ablation in patients with refractory atrial fibrillation and rapid ventricular response. Since then, direct current catheter ablation (which was associated with an

Abbreviations: WPW, Wolff-Parkinson White syndrome; NIS, Nationwide Inpatient Sample; HCUP, Healthcare Cost and Utilization Project; AHA, American Heart Association; NHDS, National Hospital Discharge Survey; ICD, International Classification of Diseases; PSI, Patient Safety Indicators; LOS, length of stay; NAPSE, North American Society of Pacing and Electrophysiology; MERFS, Multicenter European Radiofrequency Survey.

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increased risk of barotrauma) has been replaced by radiofrequency catheter ablation resulting in increasing number of patients being safely treated for arrhythmias. Radiofrequency catheter ablation for accessory pathway has become the preferred treatment modality in patients with symptomatic accessory pathways with or without tachycardia [6–9]. Given paucity of data regarding the experience at the national level in United States, we designed the study to determine temporal trends of accessory pathway catheter ablation in the United States using a large national database.

2. Methods

2.1. Data source

We analyzed data from the Nationwide Inpatient Sample (NIS), provided by the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality, Rockville, MD from the years 1998–2011. This registry represents up to 8 million hospital stays from 1000 hospitals accounting for 20% of all inpatient admissions to non-federal hospitals in United States. It contains discharge-level data provided by states, which participate in HCUP. This database has been used previously to study trends and predictors of healthcare usage, patterns of major procedures, access, disparity of care, procedural adverse effect, hospitalization trends, charges, quality and outcomes [10–13]. Each individual hospitalization is de-identified and maintained in the NIS as a unique entry with 1 primary discharge diagnosis and ≤24 secondary diagnoses during that hospitalization. This registry also incorporates one primary procedure code and up to 15 secondary procedure codes. Each entry also carries information on demographic details, co-morbidities, hospitalization outcome and length of stay.

Annual data quality assessments of the Nationwide Inpatient Sample are performed, which guarantee the internal validity of this database. Furthermore, estimates from the NIS are compared to American Hospital Association (AHA) Annual Survey Database, the National Hospital Discharge Survey (NHDS) from the National Center for Health Statistics, and the MedPAR inpatient database from Centers of Medicare and Medicaid. Detailed reports regarding the data quality of NIS are available at the following website: http://www.hcup-us.ahrq.gov/db/nation/nis/nisrelatedreports.jsp.

2.2. Study design

Patients aged ≥18 years with a primary diagnosis of anomalous atrioventricular excitation syndrome (*International Classification of Diseases, Ninth Edition, Clinical Modification* [ICD-9-CM] code 426.7) were included in the study. Patients who underwent catheter ablation were identified using ICD-9-CM procedure code 37.34. Patients with concomitant atrial fibrillation, atrial flutter, atrial tachycardia and ventricular arrhythmias were excluded from the analysis (Supplementary Table 1).

2.3. Procedural complications

We used Patient Safety Indicators (PSIs) to identify preventable procedural complications, which have been established by the Agency for Healthcare Research and Quality to monitor preventable adverse events during hospitalization. These indicators are based on ICD-9-CM codes and Medicare severity Diagnosis-Related Groups and each PSI has specific inclusion and exclusion criteria. The PSI individual measure technical specifications, Version 4.4, March 2012 (http://www.qualityindicators.ahrq.gov/modules/PSI_TechSpec.aspx) was used to identify & define preventable complications viz. post-procedure acute renal failure requiring dialysis, post-procedure pulmonary embolism or deep vein thrombosis, post-procedure infectious complications which included postoperative sepsis & central venous catheter related bloodstream infections, iatrogenic pneumothorax, complications of anesthesia, and accidental puncture or laceration. Other procedure related complications were identified using ICD-9-CM codes (listed in Supplementary Table 1) in any of the secondary diagnoses fields. In order to prevent classification of a pre-existing condition (e.g. stroke or heart block) as a complication, cases with the ICD-9-CM code for a complication listed as the principal diagnosis (DX1) were excluded.

2.4. Hospital procedure volume

Hospital volume was computed using unique hospital identification number. The number of accessory pathway ablations performed by a particular hospital in a specific year was considered to be the annual hospital volume of that hospital for that year. Hospital volume was divided into tertile for further analysis. Hospitals performing 2 or less accessory pathway ablations annually were labeled as tertile I of annual hospital volume, hospitals performing >2 ablations but up to 5 ablations were characterized under annual hospital volume tertile II and any center performing 6 or more ablations was placed under annual hospital volume tertile III.

2.5. Utilization rates

United States Census data (http://www.census.gov/popest/data/index.html) was used to calculate for population estimates of all people aged 18 years or older in order to compute time trends in utilization rate from 1998 to 2011. Since NIS represents a 20% stratified random sample of US hospitals, the population at risk forming the denominator is 20% of US census population of adults ≥18 years age for any given year.

2.6. Statistical analysis

For all variables, weighted values of patient level observations were generated; using pre-specified weights in the NIS dataset, to produce a nationally representative estimate of US hospitalized patient population.

Differences between categorical variables were tested using Pearson chi-square test and differences between continuous variables were tested using either Student's *t*-test if the variables were normally distributed or Kruskal Wallis test if they were not normally distributed. p-Value of <0.05 was considered significant.

Multivariable logistic regression models were created incorporating covariates such as patient demographics, hospital volumes, hospital bed size, hospital region (east, midwest, south or west), hospital location (rural or urban), teaching hospital status, any complication, cardiac complications, vascular complications, cerebrovascular accident, postoperative hemorrhage and acute kidney injury. The following variables were included in the model to identify predictors of any complications and cardiac complications: patient demographics, hospital volumes, hospital bed size, hospital region (east, midwest, south or west), hospital location (rural or urban), and teaching hospital status.

Stata IC 13.0 (Stata-Corp, College Station, TX) was utilized for all analyses.

3. Results

A total of 11,601 accessory pathway catheter ablations were performed from 1998 to 2011. Table 1 demonstrates the demographic characteristics, in-hospital mortality, over all complications, cardiac complications, length of stay (LOS) stratified by hospital tertiles. The mean age in our study population was 37.3 ± 14.2 years, with women being older than men (38 years versus 37 years, $p = 0.02$). The mean length of stay was 1.8 days (median 1 day). Decreased LOS was observed in hospital tertile III 1.1 days as compared to 1.7 days in tertile II and 2.2 days in tertile I, $p < 0.001$. Table 1 demonstrates baseline demographics of patients with accessory pathway ablation.

3.1. Post-procedure complications incidence

Supplementary Table 1 illustrates all post-procedure complications and ICD-9 codes used to define all listed complications. Cardiac complications (2.3%) followed by vascular complications (1.39%) and postoperative hemorrhage (1.3%) were the most common complications after accessory pathway ablation. In addition, the incidence of complete heart block requiring permanent pacemaker and pericardial complications (composite of pericardial effusion and cardiac tamponade requiring pericardiocentesis) was 1.08% and 0.9% respectively. The overall rate of any complications was 4.36%, and cardiac complications was 2.3%; there was no in-hospital mortality. In addition, overall complication

Table 1
Baseline demographics of patients with accessory pathway ablation.

Variables[a]	Hospital tertile I	Hospital tertile I	Hospital tertile III	p value[b]
Age (years)	38.33 ± 0.50	37.39 ± 0.50	36.21 ± 0.52	0.02
Length of stay (days)	2.20 ± 0.09	1.69 ± 0.07	1.51 ± 0.06	<0.001
Mortality (%)	0	0	0	
Complete heart block requiring permanent pacemaker (%)	0.6	0.18	0.3	0.08
Cardiac tamponade (%)	0.26	0	0	0.005
Pericardiocentesis (%)	0.64	0.15	0	<0.001
Pericardial complications (%)	0.72	0.15	0	<0.001
Postoperative hemorrhage (%)	0.41	0.5	0.39	0.91
Hemorrhage requiring transfusion (%)	0	0	0	–
Acute kidney injury (%)	0.37	0.18	0	0.01
Thromboembolic event (%)	0.17	0	0.16	0.09
Vascular complications (%)	0.46	0.54	0.39	0.88
Any complications (%)	2.28	1.18	0.9	0.001
Any cardiac complications (%)	1.36	0.51	0.42	0.001

[a] Continuous variables are expressed as median (IQR). Categorical variables are expressed as %.
[b] Pearson's chi-square for categorical; linear regression for continuous variables.

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