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Occurrence of Femoral Nerve Injury among Patients Undergoing Transfemoral Percutaneous Catheterization Procedures in the United States

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Abstract

Background—The proximity of the femoral nerve to the femoral artery renders it vulnerable to injury during transfemoral percutaneous catheterization (TPC) procedures.

Objective—To determine the incidence of femoral nerve injury in patients undergoing cardiac catheterization in a nationally representative inpatient database.

Methods—We analyzed data released annually from the Nationwide Inpatient Sample. We pooled data from 2002 to 2010 and, using the ICD-9-CM procedure codes, identified patients who underwent TPC. We subsequently identified occurrences of femoral nerve injury in this cohort. Baseline characteristics, comorbid conditions, in-hospital complications, and discharge outcomes—including mortality, mild disability, and moderate-to-severe disability—were compared between patients with femoral neuralgia and those without.

Results—Of the 15,894,201 patients who underwent percutaneous catheterization procedures, 597 (3.8 per 100,000 procedures) developed femoral nerve injury. The incidence of femoral nerve injury was higher in women: 57% versus 39%, $p < 0.004$. Patients with coexisting congestive heart failure or coagulopathy had a non-significant increase in the incidence of femoral nerve injury. There was no in-hospital mortality among patients who developed femoral nerve injury, but the rate of discharge to nursing facilities was higher in this cohort: 17% versus 6%, $p < 0.001$. After adjusting for age, gender, presence of congestive heart failure, and coagulopathy, femoral nerve injury during percutaneous catheterization procedures was independently associated with moderate-to-severe disability at discharge (odds ratio 2.3; 95% confidence interval 1.4–3.8; $p < 0.001$).

Conclusion—Femoral nerve injury is a rare complication of percutaneous catheterization procedures that may increase the likelihood of moderate-to-severe disability at patient's discharge.

Keywords

Femoral nerve; femoral nerve injury; transfemoral catheterization

Introduction

Unintended injury to the femoral nerve during medical and surgical procedures is relatively common, and can produce a variety of disabling symptoms. Femoral nerve injury during medical and surgical procedures is frequently self-limiting and is consequently under-reported. During the last decade, there has been a marked increase in the number of diagnostic and interventional percutaneous vascular procedures, which has resulted in a growing number of complications. The common femoral artery is considered the preferred access site of choice in

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the majority of cardiac and endovascular interventional procedures worldwide. The femoral approach has the advantages of using a larger catheter, easier cannulation, easier compression against the femoral head, and the opportunity of repeating the procedure in the same patient. The femoral nerve lays lateral to the femoral artery, and is vulnerable to injury during common interventional procedures. Access site complications of transfemoral percutaneous catheterization (TPC) are uncommon, and comprise vascular injuries requiring further intervention. Vascular access of the femoral artery for angiography or even obtaining a blood sample can lead to nerve injury by direct compression from a hematoma or a pseudoaneurysm, particularly if multiple attempts are made. Other examples of frequent complications encountered include the formation of an arteriovenous fistula or arterial thrombosis.

Early detection and proper intervention of access site vascular complications is essential to reduce subsequent morbidity and mortality. With the increased frequency of cardiac catheterization and interventional procedures, complications such as femoral neuralgia (FN) have been reported. FN can result from direct compression secondary to vascular complications such as hematoma or aneurysm formation or via injury during cannulation. Although rare, FN can lead to neurological complications ranging from mild transient cutaneous sensory to disabling motor neuropathies.

In this paper, data from the National Inpatient Sample (NIS) between 2002 and 2010 were analyzed to determine the incidence of femoral nerve injury in patients undergoing TPC and associated disability at the time of discharge.

Methods

Our analysis was based on data files from the NIS between 2002 and 2010. NIS, the largest all-payer inpatient care database created by the Agency for Healthcare Research and Quality, is a compendium of yearly discharge data from more than 1,000 short-term and nonfederal hospitals, which approximates a 20% stratified sample of U.S. hospitals. Each hospitalization is treated as an individual entry in the database, and is coded with 1 principal diagnosis, up to 14 secondary diagnoses, and 15 procedural diagnoses associated with the hospital stay. Information available from the NIS also includes patient volume and whether the admitting hospital is a teaching or a non-teaching facility. Discharge weights are provided to facilitate the projection of national estimates, along with information necessary to calculate the variance of estimates. Further details about discharge weights can be accessed on the website.

We used the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) primary or secondary procedure codes for percutaneous femoral catheterization (88.52–88.58, 37.21–37.23, and 36.01–36.06) to identify patients who underwent TPC. We used ICD-9 primary or secondary diagnosis codes for FN (956.10–956.19 and 355.20–355.29) to identify cases with FN.

Study variables included patient age, gender, and race/ethnicity. Comorbidities obtained from AHRQ comorbidity data files included diabetes mellitus, hypertension, congestive heart failure, chronic lung disease, alcohol abuse, renal failure, and coagulopathy. ICD-9-CM secondary diagnosis codes were used to identify patients with atrial fibrillation (427.3), nicotine dependence (305.1), and dyslipidemia (272.0). ICD-9-CM secondary diagnosis codes were used to identify those with common hospitalization-associated complications such as myocardial ischemia (410.0–410.9); pneumonia (486, 481, 482.8, and 482.3); urinary tract infection (599.0 and 590.9); and sepsis (995.91, 996.64, 038, 995.92, and 999.3). We also used procedure codes to estimate the percentage of patients who underwent in-hospital procedures such as intubation (96.04) and transfusion (99.04). Discharge status was categorized into home/self-care, nursing facility, unknown, and in-hospital mortality.

Statistical Analysis

The SAS 9.1 software (SAS Institute, Cary, NC, USA) was used to convert NIS database data into weighted counts to generate national estimates, following recommendations by the Healthcare Cost and Utilization Project. We performed univariate analysis, chi-square for categorical, and *t*-test for continuous variables to identify differences in study variables and endpoints between patients with or without FN. Logistic regression models were created to identify the association between FN and odds of discharge to a nursing facility. The logistic regression model was adjusted for age as a continuous variable, gender as a categorical variable, and confounding factors as a categorical variable that were significant ($p < 0.05$) in the univariate analysis.

Results

A weighted sample of 15,894,201 patients was used in this study, 597 of whom were diagnosed with FN following TPC. Table 1 summarizes the demographic characteristics of patients with and without FN. The mean

Table 1.Demographic/Comorbidities Characteristics

	Patients without FN (% of total *n*)	Patients with FN (% of total *n*)	*p* value
Female Gender	39.3%	56.6%	<0.0001
Average age in years (CI)	64 (63–64)	61 (59–62)	
Ethnicity			<0.0001
White	58%	50.9%	
Black	8%	12.7%	
Hispanic	5.7%	7.5%	
Other	4.3%	6.4%	
Comorbidities			
Hypertension	63.3%	68.5%	0.005
Diabetes Mellitus	26.7%	32.7%	0.001
Dyslipidemia	3.8%	19.3%	<0.0001
Atrial Fibrillation	11.2%	9.4%	0.11
Congestive Heart Failure	2.8%	6.2%	<0.0001
Chronic Lung Disease	18%	11.7%	<0.0001
Coagulopathy	3.1%	7.1%	<0.0001
Renal Failure	8.7%	9.9%	0.3
Smoking	17.7%	13.6%	0.008
Alcohol Abuse	2.3%	1.7%	0.3

Table 2.In-hospital Complications and Procedures

	Patients without FN (% of total *n*)	Patients with FN (% of total *n*)	*p* value
In-hospital Complications			
Pneumonia	2.7%	0.8%	0.004
Urinary Tract Infection	3.7%	7%	<0.0001
Sepsis	0.96%	0.8%	0.8
Myocardial Infarction	4.4%	3.9%	0.5
In-hospital Procedures			
Angiography	0.5%	0.7%	0.7
Gastrostomy	0.2%	0%	
Intubation and Mechanical Ventilation	2.6%	0.8%	0.007
Transfusion	5%	11.7%	<0.0001

Table 3.Hospital Conditions and Discharge Disposition

	Patients without FN	Patients with FN	*p* value
Mean LOS in days (CI)	4.7 (4.7–4.71)	6.7 (6.2–7.2)	<0.0001
Discharge Disposition			
% to Nursing Facility	6.1%	17.4%	<0.0001
% to Other	4.2%	0.5%	
Mean Hospital Charges (CI)	$56,995.24 (56,960.63–57,027.85)	$57,086.45 (52,755.19–61,417.71)	0.97

age of patients with FN was significantly lower than the age of patients without this complication ($p < 0.0001$). Women and minorities had a significant increased risk of developing FN after femoral percutaneous vascular procedures ($p < 0.0001$).

The occurrence of FN was significantly higher in patients who have been diagnosed with hypertension, diabetes mellitus, dyslipidemia, congestive heart failure, and coagulopathy ($p < 0.0001$; Table 1).

With regard to in-hospital complications and procedures, FN has been associated with significantly higher occurrence of urinary tract infections and transfusion, and significantly less incidence of pneumonia and ventilator-dependent respiratory failure (Table 2).

When looking at hospital characteristics and discharge disposition, there was a significant increase in the length of hospital stay without a significant increase in hospital charges in patients with FN compared with those without (Table 3). The number of discharges to skilled nursing facilities was significantly higher in patients with FN when compared with those without. Our data further revealed a significant effect on discharge disposition, as patients with FN were more likely to be discharged to a nursing home facility than to home or self-care.

Discussion

Femoral neuropathy/neuralgia secondary to TPC is uncommon, but occasionally disabling. This study, representing a cohort of 15,894,201 patients who underwent TPC between 2002 and 2010, is the largest to specifically evaluate the incidence of and risk factors associated with FN, as well as its impact on functional outcome at patient discharge. The main results of this study can be summarized as follows: 1) the incidence of FN after TPC is higher in women and in patients with dyslipidemia, congestive heart failure, and coagulopathies; 2) the occurrence of FN after TPC was associated with a

higher rate of urinary tract infections; and 3) the incidence of FN also correlated with a higher length of stay. This study demonstrated the prognostic impact of FN after TPC at the time of discharge, with the increased likelihood of moderate-to-severe disability.

In a study of 9,585 femoral-approach cardiac catheterization procedures performed between 1988 and 1993, Kent *et al*. reported an incidence of femoral neuropathy of 0.2%. In this study, the incidence was 3.8 per 100,000, which may be an underestimate of the actual occurrence: not all patients were evaluated for signs and symptoms of FN. Patients who had mild neuropathy symptoms or had neuropathy prior to the TPC procedure may not have reported their symptoms to the evaluating clinicians and would, therefore, contribute to the low incidence of FN in this study. In addition, because of the substantial time lapse between the two studies, the difference can also possibly be attributed to enhanced operator skills and the use of improved devices in TPC.

In analyzing the existing comorbidities in patients in this study, female gender, African–American, and Hispanic ethnicity were significant contributors (57%, 12.7%, and 7.5%, respectively) to a higher incidence of FN. The incidence of FN was also observed to be higher in younger patients, but the average age differed by only 3 years in the 2 groups. Although female gender was associated with a higher incidence of FN in this study, the exact mechanism or explanation is unclear. Several earlier studies revealed that women possess an intrinsic vulnerability to periprocedural complications during and early after an invasive procedure such as TPC. Another potential explanation of this observation is that women have a smaller and shorter common femoral artery than men, which makes access challenging, especially when using anatomical landmarks. This characteristic increases the possibility of either direct or indirect injury to the femoral nerve.

This study revealed a higher incidence of FN in patients with hypertension, diabetes mellitus, dyslipidemia, congestive heart failure, and coagulopathy. The exact association is unclear, but a higher risk of concomitant atherosclerotic changes in the arterial wall and associated vascular complications may contribute to this association. There was no in-hospital mortality or intracranial hemorrhage reported among patients with FN. More patients with FN were discharged to nursing home facilities. The occurrence of FN was also independently associated with moderate-to-severe disability at discharge.

This study is limited secondary to its retrospective design. There was also no pre-procedural evaluation of patients for neuropathy and no objective method of evaluating for and confirming FN in patients who developed this complication. In one study, the presence of a pseudoaneurysm at the puncture site was a common lesion associated with subsequent FN. However, our data source did not allow exploration of local femoral vascular complications that can potentially lead to FN.

Conclusion

The femoral artery remains the preferred route of vascular access in the expanding arena of vascular intervention. FN is a rare complication of TPC, which may increase the likelihood of longer length of stay and moderate-to-severe disability at the time of discharge.

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