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National Trends in Foot and Ankle Arthrodesis: 17-Year Analysis of the National Survey of Ambulatory Surgery and National Hospital Discharge Survey

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ABSTRACT

Foot and ankle arthrodesis reliably reduces pain and functional disability among patients with arthritis and deformity. Since its introduction in 1953, improvements in surgical technique have enhanced the outcomes and reduced complications. However, little is known regarding US national trends of foot and ankle arthrodesis. The present study sought to use the most recently available Centers for Disease Control and Prevention data to investigate changes in the usage of inpatient and ambulatory foot and ankle arthrodesis. Cases of foot and ankle arthrodesis were identified using the National Hospital Discharge Survey and National Survey of Ambulatory Surgery, and the data were analyzed for trends in demographics, treatment, and usage. From 1994 to 2006, the population-adjusted rates of foot and ankle arthrodeses increased by 146% (8.2/100,000 capita to 20.2/100,000 capita). The number of outpatient arthrodeses performed with arthroscopic assistance increased by 858%. The population-adjusted rate of outpatient and inpatient procedures increased by 415% and 17%, respectively. The gender-adjusted rates increased by 59% for males and 209% for females. The age-adjusted rates increased among patients >35 years old in both settings. The use of peripheral nerve blocks during ambulatory procedures increased from 3.3% to 10.1%. Private insurance was the largest compensator. In conclusion, the rate of foot and ankle arthrodesis increased dramatically from 1990 to 2007 using the most up-to-date publicly available data. Knowledge of these national practice patterns could aid policy-makers and surgeons in appropriately allocating healthcare resources to ensure quality patient care.

Ankle arthrodesis, originally used to treat tuberculosis of the ankle joint (1), is now performed to relieve functionally disabling ankle pain and joint destruction not alleviated by nonoperative methods (2). Similarly, arthrodesis of the hindfoot (3–6), midfoot (7,8), tarsometatarsal (9), and metatarsophalangeal (10) and triple arthrodesis of the talocalcaneal, talonavicular, and calcaneocuboid joints (11) can treat functional impairment and deformity secondary to Charcot arthropathy, trauma, degenerative joint disease, and rheumatoid arthritis (12). A variety of surgical techniques exist for achieving fusion of the joints in the foot and ankle, ranging from external fixator-assisted arthrodesis (13–15) to open arthrodesis (1,16–23) and arthroscopically assisted arthrodesis (24,25). The results after open and external fixator-assisted arthrodesis have been historically good, with reductions in pain (22,26), improvements in function (27,28), and high fusion rates (13,20). Recently, however, arthroscopically assisted arthrodesis has been suggested to be superior to open arthrodesis (5,29,30), with studies revealing high fusion rates (31,32) and mean times to ankle arthrodesis of nearly half (24) compared with open techniques. Many studies evaluating the outcomes and techniques of foot and ankle arthrodesis were based on small cohorts and little is known regarding US national trends. Knowledge of the patterns of disease burden is necessary for the appropriate allocation of limited healthcare resources.

We sought to determine the national incidence and trends in use of foot and ankle arthrodesis in the United States. We hypothesized that the rates of ambulatory foot and ankle arthrodesis and arthroscopically assisted procedures have increased over time. Our primary aim was to determine national trends in resource usage for ambulatory and inpatient foot and ankle arthrodesis with a specific focus on age, gender, surgical setting, arthroscopic assistance, anesthetic type, and payment method. We undertook a descriptive

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epidemiologic study to evaluate national trends in foot and ankle arthrodesis.

Materials and Methods

Data Source

The primary aim of the present study was to analyze trends in foot and ankle arthrodesis from 1990 to 2007 using the National Survey of Ambulatory Surgery (NSAS) (33) and National Hospital Discharge Survey (NHDS) (34) databases. Because the NSAS and NHDS are administrative data sets in which all data are de-identified and available for public use, our study was exempt from approval by our institutional review board.

As the principal database used by the US government for monitoring nonfederal, short-stay hospital use, the NHDS represents the most recent, publicly available national data from the Centers for Disease Control and Prevention (Atlanta, GA) (35). The NHDS uses a stratified multistage probability design to retrieve an annual sample of >250,000 discharges from nonfederal short-stay hospitals (average length of stay <30 days) in the United States and District of Columbia (36). The NHDS collect demographic information (age, gender, race), medical information on ≤7 discharge diagnoses and ≤4 procedures, length of care, hospital size, expected source of payment (insurance status), US region, and inpatient outcomes, including discharge destination (34). In contrast, the NSAS, conducted in 1994, 1996, and 2006, was a national study involving both hospital-based and freestanding ambulatory surgery centers (33), which provides the most recent and comprehensive overview of ambulatory surgery in the United States (37). Both surveys use the *International Classification of Diseases,* 9th Revision, Clinical Modification codes (38) to classify medical diagnoses and procedures. To produce an unbiased national estimate, the surveys used multistage estimate procedures, including inflation by reciprocals of the probabilities of sample selection, adjustment for no response, and population weighting ratio adjustments (35,39).

Study Population

The demographic and medical information was obtained for individuals undergoing foot and ankle arthrodesis from 1990 to 2007. Discharges with a procedure code (*International Classification of Diseases,* 9th Revision, Clinical Modification) of 81.1x (arthrodesis of ankle/foot) were included in the sample using previously described techniques (40,41). These procedure codes included ankle fusion (81.11), triple arthrodesis (81.12), subtalar fusion (81.13), midtarsal fusion (81.14), tarsometatarsal fusion (81.15), and metatarsophalangeal fusion (81.16). Discharges with a concurrent procedure code of ankle arthroscopy (80.27) were identified as undergoing arthroscopically assisted arthrodesis. Data were recorded for age, gender, facility type, insurance type, anesthesia type, diagnoses, and procedures.

Statistical Analysis

A normal distribution of the data was assumed because of the large sample size. Descriptive statistics for continuous variables consisted of the mean ± standard deviation and frequency and percentages for discrete variables. Because the survey data were collected using a probabilistic sample scheme, the data were analyzed using a sampling weighting method. Sampling weights (the inverse of selection probability) provided by the Centers for Disease Control and Prevention were used to account for unequal sampling probabilities and to produce estimates for all visits in the United States. A Taylor linearization model provided by the Centers for Disease Control and Prevention estimates was used to calculate the standard error and 95% confidence intervals (CIs) of the data. The standard error is a measure of sampling variability that occurs by chance because only a sample rather than the entire universe is surveyed. The 95% CIs and a point estimate were selected to define the population parameters. When compared between years, the 95% CIs can be suggestive of statistical differences if the data are nonoverlapping; however, direct statistical comparison between years could not be performed owing to sampling differences in the database. To obtain national population estimates for each year of the study, US census data were used from 1990 to 2007 (42). The rates are presented as the number of procedures per 100,000 standard population. Gender-specific rates were applied to the standard population, and dividing by the total in the standard population allowed for calculation of gender-adjusted rates for each year. For age, a direct adjustment procedure was used, and the US population in 2000 was selected as the standard population. All data were analyzed using the software Statistical Package for Social Sciences, version 20 (SPSS, Chicago, IL).

Table 1
Changes in population-adjusted and gender-adjusted rates of ambulatory and inpatient foot and ankle arthrodesis

Variable	1994	1996	2006	Change (2006 versus 1994) (%)
Ambulatory				
Male	2.5	1.6	4.9	96
Female	3.3	4.3	21.4	548
Overall	2.7	2.8	13.9	415
Inpatient				
Male	5.1	4.7	5.9	16
Female	6.6	6.9	6.1	−8
Overall	5.4	5.5	6.3	17
Inpatient and ambulatory combined				
Male	7.1	5.9	11.3	59
Female	9.3	10.6	28.7	209
Overall	8.2	8.3	20.2	146

Funding Source

No external funding source was used for the present study.

Results

Total Procedures

A cohort representative of 39,154 ambulatory foot and ankle arthrodeses (95% CI 35,332 to 42,975) or 13.9 per 100,000 capita were recorded by the NSAS in 2006 (Table 1). This represents a large increase in the total number of ambulatory procedures from 7662 (95% CI 7019 to 8305) in 1994 (2.7 per 100,000 capita), and 7932 (95% CI 7279 to 8585) in 1996 (2.8 per 100,000 capita; Fig. 1). Inpatient procedures increased from 12,738 (95% CI 11,572 to 13,903) in 1990 (5.1 per 100,000 capita) to 15,406 (95% CI 11,963 to 18,848) in 1996 (5.5 per 100,000 capita) to 17,723 (95% CI 10,428 to 25,017) in 2006 (6.3 per 100,000 capita; Table 1 and Fig. 1).

Total Number of Procedures by Anatomic Location

The changes in inpatient and ambulatory foot and ankle arthrodesis from 1994 to 2006 with regard to anatomic location are listed in Table 2. The population-adjusted rate of ankle arthrodeses performed in the outpatient setting increased 108% from 1994 to 2006. The largest overall increase was seen among tarsometatarsal fusions (1304%). The greatest increases in the ambulatory and inpatient setting were seen among subtalar fusions (11,943%) and tarsometatarsal fusions (453%), respectively.

Arthroscopically Assisted Procedures

From 1994 to 2006, the proportion foot and ankle arthrodeses performed with arthroscopic assistance increased from 5.0% to 9.4%.

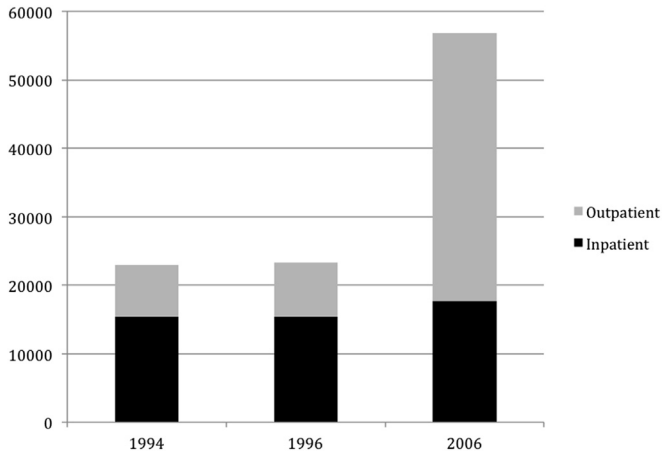

Fig. 1. Volume of inpatient and ambulatory foot and ankle arthrodeses in 1994, 1996, and 2006.