Evaluation of the Safety of Arteriovenous Fistula Creation Surgery in Ambulatory versus Inpatient Hospital Setting

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ABSTRACT. Arteriovenous fistula (AVF) creation surgeries necessary for dialysis in patients with end-stage renal disease have traditionally been performed in inpatient settings under general anesthesia. Although more recent studies have demonstrated that these surgeries can be safely performed in outpatient centers with low postoperative complication rates, a direct comparison to surgeries performed in inpatient settings has not been investigated. This study sought to directly compare the rate of complications and postoperative mortality in AVF creation surgeries performed in outpatient and inpatient surgical centers. This multicenter retrospective study recorded emergency department (ED) visits, inpatient admissions, and mortality following 179 outpatient and 146 inpatient AVF surgeries in 2015 and 2016. Rates of mortality at 30 days and ED visits and inpatient admissions at 24-h and seven-day time points were compared in inpatient and outpatient groups. Following outpatient and inpatient surgeries, the rates of inpatient admissions in seven days were 0.685% and 4.47%, respectively, and the rates of ED visits in seven days were 1.37% and 3.91%. There were no mortalities in either group in 30 days. There was no difference between groups in the rate of ED visits within seven days or hospital visits within 24 h. There was a significantly lower rate of admissions (P = 0.0386) and total hospital visits (P = 0.0131) within seven days for outpatient surgeries. This study provides a direct comparison of postoperative complications in inpatient and outpatient AVF surgeries, further suggesting that providers can safely perform AVF surgeries in ambulatory centers.

Introduction

The prevalence of end-stage renal disease (ESRD), defined as a reduction of kidney function to an estimated glomerular filtration rate of <15 mL/min/1.73 m², is rising in the United States, with over 661,000 patients receiving treatment for ESRD in 2013.¹ While renal transplantation is the preferred treatment for ESRD patients, providing an improved quality of life and a reduction in mortality compared to dialysis, it is not an appropriate option for all patients and is associated with potentially long waiting times.²,³ While waiting for an available kidney, patients must often undergo
maintenance dialysis, which requires a reliable and stable access to the bloodstream typically in an easily accessible nondominant upper extremity. This vascular access is most commonly provided through the creation of a primary arteriovenous fistula (AVF), which offers higher rates of patency and fewer complications than other vascular access methods such as tunneled catheters and synthetic bridge grafts.

Given the multitude of disorders and comorbidities associated with declining renal function such as cardiovascular disease, hypertension, and diabetes mellitus, AVF creation surgery has traditionally been performed in an inpatient hospital setting, and patients have generally not been considered good candidates for surgery in a free-standing outpatient facility. Such surgeries were commonly performed under general anesthesia, even with the anesthesia-related risks in patients with advanced chronic kidney disease.

Increasingly, AVF creation surgery has been carried out in an outpatient setting at ambulatory surgical centers. Several studies have demonstrated that these surgeries can safely be performed in such ambulatory centers with low postoperative complication rates, despite patient comorbidities particularly when paired with a regional anesthetic technique instead of general anesthesia. A recent retrospective analysis has demonstrated that both local anesthesia and brachial plexus blocks are effective modalities in AVF surgery with markedly low rates of conversion to general anesthesia. In addition to the benefits of improved analgesia and lower rates of complications seen with regional anesthesia, brachial plexus blocks may also promote successful outcomes through increased arterial and venous dilation, improved fistula patency, and potentially decreased postoperative length of stay. Prior studies have demonstrated that AVF surgery can be safely performed in an outpatient setting with a mean postoperative stay of only 112 min. As has occurred in other institutions, the shift toward performing AVF surgeries at ambulatory surgical sites has taken place in the Montefiore Medical Center (MMC) in Bronx, NY, USA. In 2015, the Hutchinson ambulatory site was opened as an extension of the existing inpatient hospital network and soon began to be used as an additional site for AVF surgeries in the same pool of patients. There are no patient factors that contribute to selection for surgery at a particular site, and patients at inpatient and outpatient sites are under the care of the same rotating vascular surgical service. However, rather than general anesthesia, regional anesthesia with sedation is the standard of care for these surgeries performed at the Hutchinson ambulatory site.

While earlier studies have evaluated the safety of vascular access surgery as an outpatient procedure, there has not been a direct safety comparison to similar surgeries performed in an inpatient setting. This study sought to directly compare the rate of complications and postsurgical mortality in AVF creation surgeries performed in outpatient surgical centers and inpatient hospitals among patient populations with similar characteristics and surgical indications.

**Materials and Methods**

This was a multicenter retrospective study evaluating the safety and efficacy of AVF creation surgeries in an ambulatory setting compared to an inpatient hospital setting. The inclusion criterion was any patient who had undergone an AVF creation surgery in 2015 and 2016 at hospital centers included in the study. The exclusion criterion was any patient with missing medical records.

The Clinical Looking Glass program was used to identify all AVF creation surgeries performed at the Hutchinson ambulatory surgical site at MMC and at the Moses or Weiler campuses of MMC, both inpatient hospital sites, in 2015 and 2016. The patients were separated into two groups: an outpatient surgery group, consisting of all patients whose surgeries were performed at the Hutchinson ambulatory center, and an inpatient surgery group, consisting of all patients whose surgeries were performed at the Moses or Weiler campuses.
All surgeries were performed on the same pool of MMC patients with similar comorbidities with no patient characteristics contributing to selection at one site over another. All patients were ASA 3 or 4 and were scheduled for elective AVF creation surgery for ESRD and need for renal hemodialysis. The medical records of patients in both the groups were queried for relevant demographic data, specifically age and sex, and for the following data points:

1. Hospital admission within 24 h postsurgery
2. Hospital admission within 7 days postsurgery
3. Emergency department (ED) visit within 24 h postsurgery
4. ED visit within 7 days postsurgery
5. Mortality at 30 days postsurgery.

In the statistical analysis, continuous variables were analyzed using Student’s t-test, and categorical variables were analyzed using Chi-square analysis. All analyses considered a \( P = 0.05 \) to be statistically significant.

Data with patient-identifying information were collected on a password-protected computer to protect patient confidentiality. The Institutional Review Board of the MMC approved this study and waived the requirement for informed consent.

Results

During 2015 and 2016, there were 179 surgery group and 146 AVF surgeries in the outpatient surgery group. The groups were similar in most categories, including proportion of male and female patients, though the mean age was significantly higher in the inpatient surgery group than in the outpatient surgery group (61.8 vs. 58.6 years, \( P = 0.0239 \)) (Table 1). There were no deaths within 30 days in either group. There was no significant difference between the groups in the rate of ED visits within seven days or hospital visits (including admissions and ED visits) within 24 h (Table 2). There was a significantly lower rate of inpatient admissions and total hospital visits within seven days post-AVF creation for surgeries performed in the ambulatory center.

Discussion

The safety of vascular access surgeries performed in outpatient settings has been demonstrated in previous studies. In spite of the numerous comorbidities commonly present in ESRD patients, these surgeries have been shown to result in low rates of postoperative complications. The results of this study align with those earlier findings, building upon them to provide a direct comparison of the safety of outpatient surgeries to those performed in more traditional inpatient settings through evaluation of postoperative hospital visits and mortality. This study found that patients whose

### Table 1. Demographic characteristics of arteriovenous fistula surgery groups.

| Demographic       | Outpatient surgeries | Inpatient surgeries | \( P \) |
|-------------------|----------------------|---------------------|--------|
| Total surgeries   | 146                  | 179                 | -      |
| Mean age          | 58.6                 | 61.8                | 0.0363 |
| Proportion female | 0.384                | 0.374               | 0.864  |
| Proportion male   | 0.616                | 0.626               |        |

### Table 2. Rates of hospital visits following arteriovenous fistula surgeries.

|                      | Outpatient surgeries (%) | Inpatient surgeries (%) | \( P \) |
|----------------------|--------------------------|-------------------------|--------|
| All inpatient admissions: 7 days | 0.685                    | 4.47                    | 0.0386 |
| All ED visits: 7 days       | 1.37                     | 3.91                    | 0.165  |
| All hospital visits (ED visit or admission): 24 h | 0.685                    | 3.91                    | 0.0619 |
| All hospital visits (ED visit or admission): 7 days | 2.05                     | 8.38                    | 0.0131 |

ED: Emergency department.
Surgeries were performed at an ambulatory center had a lower rate of hospital admissions and hospital visits within seven days and no difference in emergency room visits or mortality compared to those performed at inpatient centers. Hospital admissions and postoperative mortality can be dependent on a multitude of variables, but as the pool of patients at the different surgical locations was the same, we do not have a definitive explanation for the differences observed in the study. However, the data support the primary purpose of the analysis, demonstrating that these operations, previously performed only in more advanced inpatient settings, can be safely performed in outpatient setting in these high-risk patients.

Previous data suggest that, in addition to being safe, vascular access surgeries performed in outpatient settings are also effective, particularly when paired with regional anesthesia techniques. Because ESRD patients may have greater risk factors and comorbidities that may complicate the use of general anesthesia, an emphasis on regional anesthesia techniques at outpatient centers may be preferable. In addition to avoiding general anesthesia, regional anesthesia use improves pain control, results in lower rates of complications, and promotes successful outcomes in vascular access surgeries through vasodilation, venodilation, and improved fistula patency. At the outpatient center included in this study, the standard of care in AVF surgeries is to provide regional anesthesia with sedation rather than general anesthesia. As the indications for surgery and pool of patients for surgeries at the inpatient and outpatient centers included in this study were the same, the differences in postoperative admissions and complications may very likely be due to the anesthetic management of patients having surgeries performed at the outpatient center. Other benefits of outpatient surgeries to patients include increased convenience and comfort, providing an alternative to the potentially intimidating and confusing hospital setting and allowing patients to recover in their own homes.

As the prevalence of ESRD and the concurrent demand for vascular access surgeries in dialysis patients continues to rise in the United States, potential opportunities for cost reduction become increasingly significant. These results build on those of previous studies to demonstrate that AVF surgeries can be performed in outpatient settings with no significant impact on efficacy or safety. Surgeries performed in outpatient settings such as ambulatory surgical centers have reduced health-care costs in the US by more than $38 billion annually, with more than $5 billion directly decreasing costs to patients through reduced coinsurance and deductible payments. Movement of more surgical procedures to ambulatory centers could result in a total reduction of costs of $55 billion annually. The movement of certain procedures, such as vascular access surgeries, to ambulatory centers specialized in performing scheduled outpatient surgeries can lead to increased efficiency and a reduction in hospital burden, freeing up inpatient centers for more invasive or emergent procedures.

The current study has some notable limitations. The population of patients whose AVF surgeries were performed at the ambulatory center were significantly younger than those whose surgeries were performed in an inpatient hospital setting (58.6 vs 61.8 years) though the average age difference was <3 years and likely did not play an independent role in the measured differences in postoperative hospital visits. Rates of patient comorbidities were not measured or compared between the two groups, so it is possible that the patients who had outpatient surgeries were, on average, healthier and had fewer comorbidities than those who had inpatient surgeries. In addition, the study focused on AVF surgeries in a single hospital system within a two-year period, limiting the number of patients in the study. Future studies should seek to include more patients across a greater number of centers and should take into account patient comorbidities that could impact postoperative complication rates. By offering a direct safety comparison between surgeries in inpatient and outpatient settings,
this study provides valuable, compelling new information and supports our primary hypothesis that AVF surgeries can be safely performed in ambulatory centers without sacrifice to patient outcomes. These findings, in combination with the potential for reduced overall costs and hospital burden and increased convenience and comfort to patients, provide robust support for the movement of AVF surgeries to an outpatient setting.

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