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REVIEW ARTICLE

Lateral Versus Midline: A Retrospective Review of Paracentesis Site Location and Risk of Hemorrhagic Complication

Josef Miller, MD[1,2]
Tracy Dinh, MD[1,3]
Cole Pieroni, MS[4]
Agostina Velo, MD[5]
Anne Pohlman, BSN, MSN[1]
Gaurav Ajmani, MD[1]
Krysta Wolfe, MD[1]
Bhakti Patel, MD[1]
John P. Kress, MD[1]

OBJECTIVES: Patients who have cirrhosis, malignancy, or heart failure frequently accumulate ascitic fluid in their peritoneal cavity. Percutaneous drainage of ascites is a common procedure to provide diagnostic and/or therapeutic benefit to the patient; however, this procedure is associated with a small but life-threatening risk of hemorrhage. Given the avascular nature of the linea alba, it was hypothesized that a midline approach would reduce the risk of hemorrhage.

DATA SOURCES: Data were collected from the electronic medical record. This review was authorized by the University of Chicago, Institutional Review Board 20-0083.

STUDY SELECTION: Using the electronic medical record, 1798 patients were identified using *International Classification of Diseases*, 9th revision and *International Classification of Diseases*, 10th revision codes between January 1, 2011, and January 1, 2020.

DATA EXTRACTION: We conducted a retrospective chart review of 1798 patients who underwent 4563 percutaneous abdominal paracentesis events with ultrasound guidance. Four thousand five hundred thirteen of those procedures had information about procedure location. The location of catheter placement, lateral vs. midline, was recorded in conjunction with occurence rate of post-paracentesis clinically significant hemorrhage, defined as CT imaging with evidence of hemorrhage at the procedural site within 7 days of paracentesis that required either blood transfusion, angiographic intervention, or resulted in death. Baseline characteristics were also collected, including age, sex, body mass index, volume of ascites drained, baseline hemoglobin, platelet count, international normalized ratio, serum sodium, creatinine, bilirubin, albumin, and etiology of ascites. Among paracentesis events for patients with a diagnosis of cirrhosis ($n = 2497$), 2206 has sufficient data to calculate a Model for End-Stage Liver Disease (MELD) 3.0 score and 2202 had sufficient data to determine Child-Pugh Classification.

DATA SYNTHESIS: Among patients receiving paracentesis, the overall occurence rate of hemorrhage was 1.3% (60/4563). There was a statistically significant reduction in the occurence rate of hemorrhage among patients who underwent midline percutaneous catheter placement (0/230) compared with lateral percutaneous catheter placement (60/4283; $p = 0.03$). Among patients with cirrhosis, patients undergoing lateral paracentesis ($n = 2086$) had a mean MELD 3.0 score of 22 (SD, 8.46) and patients undergoing midline paracentesis ($n = 118$) had a mean MELD 3.0 score of 25 (SD, 8.13). These groups had a statistically significant difference by Mann-Whitney *U* test ($p \leq 0.001$) with a standardized effect size of 0.071. Logistic regression was performed to identify patient variables that correlated with hemorrhage. Among these, only serum bilirubin nearly approached significance ($p = 0.07$). No baseline variable had an odds ratio that did not cross 1.0.

CONCLUSIONS: These data suggest midline paracentesis may reduce the risk of post-procedural hemorrhage among patients undergoing paracentesis.

KEYWORDS: bedside ultrasound; cirrhosis; hemorrhage; midline paracentesis; paracentesis

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KEY POINTS

Question: We hypothesize that midline paracentesis reduces the risk of procedural hemorrhage, our goal is to identify means of optimizing procedural safety in a patient population with significant risk of mortality from hemorrhage.

Findings: We found that there was a statistically significant difference in hemorrhage rate between midline and lateral paracentesis, with the midline group experiencing zero hemorrhages.

Meanings: These data suggest that midline paracentesis may be a superior procedural approach in patients with elevated risk of mortality from hemorrhage, such as those with cirrhosis or malignancy causing ascites.

Patients living with cirrhosis, malignancy, or heart failure frequently accumulate ascitic fluid in their peritoneal cavity. Because of this, paracentesis, which involves accessing the peritoneal cavity and draining fluid, is often performed. This procedure can serve a therapeutic purpose, as in a large volume paracentesis, as well as diagnostic purposes such as sampling of the fluid, which may discover infection, progression of malignancy, or signs of heart failure. For more than a decade, ultrasound guidance for all paracenteses has become standard at most institutions (1, 2). Ultrasound provides the operator with the advantage of identifying critical anatomic structures, such as superficial blood vessels and abdominal organs, namely the liver, spleen, and bowel, before attempting to access the peritoneal cavity. Paracenteses are generally safe procedures with risk of complication being around 1% (3). The most common risk of paracentesis is post-procedural hemorrhage. The exact occurence rate of this complication is unknown, but studies have shown that severe cases of hemorrhage occur in less than 0.2% of cases, particularly when bedside ultrasonography is used (3, 4). However, post-paracentesis hemorrhage can be catastrophic in the rare circumstances that it does occur.

During this procedure, ascitic fluid is assessed with an ultrasound to determine if there is a large enough pocket of fluid for the peritoneal cavity to be safely accessed with a needle without risking injury to the visceral organs. Additionally, a linear ultrasound probe is used to evaluate superficial blood vessels that could be injured during the procedure (2). If deemed safe by the operator, a needle is inserted into the cavity. Then, a catheter is advanced over the needle and fluid is drained from the peritoneal cavity. Although patients that accumulate ascites often have comorbid conditions that are associated with coagulopathy, such as cirrhosis or malignancy, previous guidelines have established that it is unnecessary to give blood products to correct international normalized ratio (INR) or thrombocytopenia before a paracentesis (1). The right and left lower quadrants are commonly used as an access site for a paracentesis as these areas typically have the largest fluid pocket and avoid organs such as the liver or spleen. However, patients have highly variable abdominal wall vessel courses (4, 5); accordingly, using these sites can lead to hemorrhage from the inferior epigastric, circumflex iliac, and subcostal arteries. A midline approach to paracentesis may offer a safer alternative, since the linea alba consists of connective tissue without arteries, veins, or nerves. Midline paracentesis is performed using the same method of ultrasound assessment and catheter placement as the conventional approach. The location of percutaneous access is 2–3 cm below the umbilicus.

To our knowledge, there have been no comparative studies evaluating anatomic location when performing paracentesis. As such, we performed a retrospective evaluation of a lateral vs. midline approach with regard to hemorrhagic complications related to the procedure.

METHODS

In this retrospective chart review, patients from January 1, 2011, to January 1, 2020, at a single academic center that underwent ultrasound-guided bedside paracentesis procedures were identified based on *International Classification of Diseases*, 9th revision and *International Classification of Diseases*, 10th revision codes (2). Per institutional standards, sterile technique and a two-probe ultrasound technique were used (2). Paracentesis was performed by experienced operators. Each operator used their own discretion in terms of the safety of performing paracentesis based on each patient's laboratory values and available fluid pocket based on ultrasound examination. Baseline information such as the patient's age, body mass index, and

etiology of ascites was collected. Demographic information was analyzed using the Mann-Whitney *U* test for continuous variables and the chi-square test for categorical variables. Data on the anatomic location of the paracentesis procedure and volume removed as well as whether there was hemorrhage seen on CT abdomen/pelvis or angiography within the seven days following the paracentesis was abstracted from the patient charts. For purposes of this study, hemorrhage was defined as CT imaging with evidence of hemorrhage at the procedural site within 7 days of paracentesis that required either blood transfusion, angiographic intervention, or resulted in death.

Laboratory data on each patient's baseline hemoglobin, platelet count, INR, serum sodium, creatinine, bilirubin (total), and albumin were also included. These values were used to compute Model for End-Stage Liver Disease (MELD) 3.0 scores for patients that had sufficient information ($n = 2086$). Child-Pugh classification was calculated for patients that had sufficient information ($n = 2202$). Logistic regression was performed to identify patient variables that correlated with hemorrhage. Age, sex, etiology of ascites, platelet count, bilirubin (total), albumin, creatinine, and procedural site (lateral or midline) were assessed with the outcome being hemorrhage or no hemorrhage. Odds ratios were calculated for each variable.

Patient charts for those who had hemorrhage events were reviewed to determine if the hemorrhage could be attributed to the paracentesis procedure. If there was physical examination findings (such as hematoma) or CT or angiographic evidence of bleeding ipsilateral to the paracentesis procedure and within 7 days of paracentesis, the hemorrhage was attributed to the procedure. Death associated with post-paracentesis hemorrhage was determined by review of discharge documentation in individuals with CT or angiography-confirmed post-procedural hemorrhage. A total of 1798 patients that underwent 4563 percutaneous abdominal paracentesis events were studied. Because some patients in our study underwent multiple paracenteses over time, each individual procedure was studied as a paracentesis event. For each paracentesis event the pertinent objective data were collected, such as procedure site, demographic data, and relevant imaging and laboratories pertaining to the paracentesis event. This review was authorized by the University of Chicago, Institutional Review Board 20-0083. This study was reviewed under the title "Bleeding complication risk from midline vs. lower-quadrant approaches to paracentesis."

RESULTS

Four thousand five hundred sixty-three paracentesis events were identified. Of these, 230 were done at the midline location (5.1%) and 4283 were done at the lateral location (93.9%). The remainder did not have sufficient information to determine procedural location. For all paracentesis events, the most common etiology of ascites was cirrhosis (2497/4563, 55%) followed by malignancy (1208/4563, 26%) followed by heart failure (235/4563, 6%).There was a statistically significant difference in etiology between those who received the midline and left lower quadrant/right lower quadrant procedures ($p < 0.05$) with 58% (133/230) of midline procedures being due to cirrhotic ascites vs. 47% (2013/4283) in the lateral approach group. Patients who underwent midline approach paracentesis had a higher median INR (1.55 vs. 1.4; $p < 0.05$), lower platelets (123 vs. 147; $p < 0.05$), and lower pre-procedure hemoglobin (8.6 vs. 9.4; $p < 0.05$).

Logistic regression was performed using age, sex, etiology of ascites, platelet count, bilirubin (total), albumin, creatinine, and procedural site (lateral or midline) with the outcome being hemorrhage or no hemorrhage. Among these variables, none demonstrated statistical significant. These data are shown in **Table 1**.

Among paracentesis events for patients with cirrhosis, 2086 events had sufficient information to calculate MELD 3.0 scores. There was a statistical difference in MELD 3.0 score ($p < 0.001$) with the average MELD 3.0 score being 22 (SD, 8.46) among patients undergoing lateral paracenteses and 25 (SD, 8.13) among patients undergoing midline paracenteses with a standardized effect size of 0.071. Child-Pugh class was also assessed for these patients with the lateral group comprising of 0% class A, 54% class B, and 46% class C. The midline group was 0% class A, 36% class B, and 64% class C. MELD 3.0 and Child-Pugh classification are shown in **Table 2**.

There was a statistically significant difference in the volume removed when using the midline approach compared with the lateral (2500 cc in the midline group vs. 3000 cc in the lateral group; $p < 0.05$). Patients who

TABLE 1.
Baseline Characteristic and Odds Ratio of Procedural Hemorrhage

Patient Data	Coefficient (β)	SE	OR (95% CI)	*p*
Intercept	−20.969	1,666.483		
Age at time of procedure	0.005	0.012	1.01 (0.93–1.03)	0.67
Sex	−0.280	0.282	0.76 (0.43–1.31)	0.32
Etiology of ascites	−0.227	0.219	0.80 (0.52–1.22)	0.30
Platelet count	−0.002	0.001	1.00 (0.99–1.0)	0.24
Bilirubin (total)	0.029	0.016	1.03 (0.99–1.06)	0.07
Albumin	−0.006	0.190	0.99 (0.69–1.44)	0.97
Creatinine	0.013	0.098	1.01 (0.84–1.23)	0.89
Procedure site (lateral or midline)	17.146702	1,666.483	27,971,659.43 (0–∞)	0.99

OR = odds ratio.

TABLE 2.
Model for End-Stage Liver Disease 3.0 Score and Child-Pugh Status Among Paracentesis Events for Patients With Cirrhosis

Patient Data	Lateral (2088)	Midline (118)	*p*	Standardized Effect Size
Model for End-Stage Liver Disease 3.0 average (interquartile range)	22 (16–28)	25 (20–30)	0.00081	0.071
Child-Pugh % (A, B, C)	(0, 54, 46)	(0, 36, 64)	NA	NA

NA = not applicable.

had a hemorrhage event had higher median INR (1.8 vs. 1.4; $p < 0.05$), lower platelets (94 vs. 146; $p < 0.05$), lower hemoglobin (8.6 vs. 9.4; $p < 0.05$) than those who did not experience hemorrhage. Baseline characteristics are shown in **Tables 3** and **4**.

There was an overall hemorrhage rate of 1.3% (60/4513). Of the 230 patients who underwent paracentesis using a midline approach, there were zero hemorrhages identified. Of the 4283 patients who underwent a conventional lateral approach, there were 60 post-procedural hemorrhages, confirmed by CT imaging (1.4 occurrence rate; $p = 0.03$). The magnitude of the hemorrhage in these 60 events was: requiring 1 or 2 U of packed RBC (PRBC) transfusion ($n = 5$); requiring greater than 2 U of PRBC transfusion ($n = 42$); requiring interventional embolization procedure ($n = 26$); and death associated with hemorrhage ($n = 10$; **Fig. 1**).

Crude mortality analysis was performed by reviewing charts at the time of data collection, 2024–2025. Mortality was 49% among study participants with cirrhosis, malignancy, and heart failure. There was no statistical difference in mortality between the etiologies of ascites ($p = 0.19$). Results of this review are shown in **Supplemental Table 1** (https://links.lww.com/CCM/H796).

DISCUSSION

In this retrospective chart review, paracentesis data from 1798 patients were analyzed to determine if the occurence rate of hemorrhage differed based on location of the paracentesis. Hemorrhage events were compared between the conventional lateral approach vs. the midline approach. Our study showed a statistically significant decrease in the rate of hemorrhage events when using the midline approach with notably zero hemorrhage events identified within this group. It is well known that the precise anatomic location of arteries (and veins) in the abdominal wall has significant variability among individual people (4, 5). This is a reason for the attractiveness of an approach where the needle and catheter pass through an anatomically avascular tissue.

TABLE 3.
Baseline Characteristics of Hemorrhage Versus No Hemorrhage

Patient Data	Hemorrhage (60)	No Hemorrhage (4503)	*p*
Age, median (IQR)	60 (48–65)	61 (52–67.5)	0.085
Gender, female (%)	53	47	
Body mass index, median (IQR)	26 (22–29)	26 (22–30)	0.09
Ascites etiology (%)			0.0098
Cirrhosis	75	61	
Malignancy	14	32	
Heart failure	11	7	
Volume removed	2300 (85–4150)	3000 (1000–5000)	0.7
Needle gauge (%)			0.92
14	81.6	84.7	
16	14.3	11.2	
20	2	2.3	
21	2	1.8	
International normalized ratio, median (IQR)	1.8 (1.4–2.5)	1.4 (1.2–1.8)	7.5×10^{-7}
Platelets, median (IQR)	94 (60–175)	146 (84–235)	2.8×10^{-4}
Hemoglobin (baseline), median (IQR)	8.6 (7.9–9.6)	9.4 (8.3–10.8)	3.6×10^{-4}
Creatinine (baseline), median (IQR)	1.7 (0.9–2.3)	1.4 (0.9–2.5)	0.9
Sodium, median (IQR)	138 (132–139)	137 (133–140)	0.84
Bilirubin, median (IQR)	4.0 (1.1–9.7)	1.3 (0.5–3.8)	1.6×10^{-6}
Albumin, median (IQR)	3.1 (2.5–3.5)	3.0 (2.5–3.5)	0.68

IQR = interquartile range.

In this study, patients who underwent the midline approach had laboratory values that are associated with increased risk of hemorrhage such as a higher INR, lower platelets, and a lower hemoglobin compared with the patients undergoing the lateral approach. Although a statistically significant difference was observed in median platelet count (147 vs. 123; $p \leq 0.05$) and median baseline INR (1.4 vs. 1.55; $p \leq 0.05$) these differences are not clinically significant and generally would not impact pre-procedure management as it relates to procedural bleeding risk. Additionally, in the midline group zero hemorrhage events were identified. This suggests that the midline approach may be superior, especially for patients with a predisposition to hemorrhage, or those that are unlikely to tolerate hemorrhage, but still require paracentesis for diagnostic or therapeutic benefit.

Paracentesis events among patients with cirrhosis were further evaluated to determine if there was difference in MELD 3.0 scores between patients undergoing lateral vs. midline paracentesis. The midline group has slightly higher MELD 3.0 scores on average, with a small effect size. These data are of little clinical significance but may further support the safety of midline paracentesis.

This study showed a hemorrhage rate of 1.3%. This hemorrhage rate is higher than a previous study in cirrhotic patients, which had a rate of 1.0% (6). Interestingly, ultrasound was not routinely used in that study yet still had a lower rate of hemorrhage when compared with our study. This could be due to the inclusion of both inpatients and outpatients in the aforementioned study. Patients in our study had the procedure done while hospitalized, suggesting an elevated degree of acuity and comorbid illness. Among patients with cirrhosis MELD 3.0 scores and Child-Pugh classifications reflect the illness severity of our study population (Table 2).

TABLE 4.
Baseline Characteristics of Lateral Versus Midline Paracentesis

Patient Data	Lateral (4283)	Midline (230)	*p*
Age, median (IQR)	61 (52–60)	60 (50–65)	0.013
Gender, female (%)	45.2	48.2	
Body mass index, median (IQR)	25 (21.5–31.0)	26.25 (21.9–30.9)	0.79
Ascites etiology (%)			0.44
Cirrhosis	65.6	59.3	
Malignancy	28.2	35.9	
Heart failure	6.2	4.8	
Volume removed	3000 (1000–5000)	2500 (557.5–4000)	0.008
Needle gauge (%)			0.008
14	84.7	87.2	
16	11.2	5.9	
20	2.3	2.5	
21	1.8	4.4	
International normalized ratio, median (IQR)	1.4 (1.2–1.8)	1.55 (1.3–2.0)	2.2×10^{-5}
Platelets, median (IQR)	147 (85–236)	123 (71–209)	2.2×10^{-5}
Hemoglobin (baseline), median (IQR)	9.4 (8.3–10.8)	8.6 (7.7–9.9)	3.7×10^{-10}
Creatinine (baseline), median (IQR)	1.4 (0.9–2.5)	1.3 (0.8–2.5)	0.39
Sodium, median (IQR)	137 (133–140)	137 (133–140)	0.19
Bilirubin, median (IQR)	1.3 (0.5–3.8)	1.9 (0.75–5.7)	4×10^{-4}
Albumin, median (IQR)	3.1 (2.5–3.5)	2.8 (2.4–3.3)	7.8×10^{-5}

IQR = interquartile range.

In another study analyzing paracenteses performed on hospitalized patients with acute on chronic liver failure, the hemorrhage rate was 3.0% (7). In this study, ultrasound was not routinely used. The difference in ultrasound use and selection bias of hospitalized patients may account for the differences in hemorrhage rates between these studies.

There was a statistically significant reduction in the volume of ascites drained with midline paracentesis. This is not unexpected given the position of the patient during a lateral approach paracentesis allows for more fluid to be obtained due to the more dependent location of peritoneal access. We find this difference in volume to be clinically insignificant, especially within the context of minimizing the risk of hemorrhage.

LIMITATIONS

This is a single-center study located in an urban area with a high proportion of complex patients, often making the urgency and risk of paracenteses elevated from the baseline. This is reflected in our rate of hemorrhage (1.4%) in our lateral approach population. We studied inpatient paracenteses, which may suggest the studied patients have an elevated risk of hemorrhage and a worse tolerance for blood loss. Although death was associated with post-procedural hemorrhage by review of the discharge summary, patients often had many comorbidities, which may have contributed to mortality. Therefore, it is difficulty to attribute death solely to procedural hemorrhage even if one was identified.

Because the explicit reason for choosing a lateral vs. midline approach was not documented in procedure notes, it is not possible to know what factors determined the operator's choice. Therefore, it is difficult to elucidate if operator skill played a role in the lower rate of hemorrhage. A randomized, prospective trial would be helpful in determining this.

Given the strong operator preference for a conventional lateral approach, there is a relative paucity of data surrounding the midline approach. Further, there were

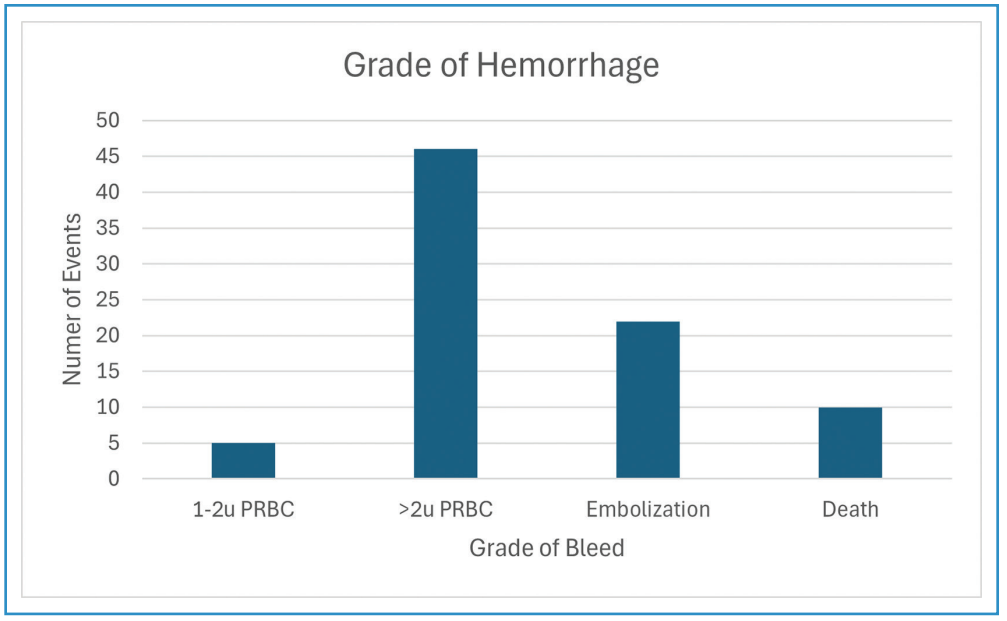

Figure 1. Grade of hemorrhage among patients with hemorrhage. PRBC = packed RBC.

relatively few midline procedures performed in this study compared with lateral (230 vs. 4283). Although it is compelling that no hemorrhages were identified in the midline approach group, additional data collection is necessary to evaluate if it is superior to lateral in other important parameters, such as volume of ascites removed, ease of access to a midline fluid collection, and safety profile in lower risk patient populations.

The study occurred in a mixed patient population primarily consisting of those with cirrhosis, malignancy, and heart failure as their etiology of ascites. Although MELD 3.0 and Child-Pugh classification was readily assessed in our study, the tumor, nodes, metastasis staging and performance status was not known for patients with malignancy and the New York Heart Association heart failure classification was not known for patients with heart failure. The absence of these data limits the determination of baseline illness severity for these groups.

Crude mortality analysis was conducted by reviewing which patients were deceased at the time of data collection, 2024–2025. Given the long period of time since the procedures were performed and comorbid illness present in our patient population, mortality was very high, at 49%. There was no significant difference in mortality between patients with cirrhosis, malignancy, and heart failure. Seeing as many patients underwent multiple paracenteses, which could include both lateral and midline approach, mortality analysis related to each paracentesis event stratified by location would be difficult to interpret.

CONCLUSIONS

Paracentesis via midline percutaneous approach has a better safety profile with regards to major hemorrhage than the conventional lateral approach. Patients undergoing each approach had comparable baseline characteristics and risk factors for procedural complication, with perhaps the midline group having increased risk factors for hemorrhage. The observed difference is likely related to the avascular nature of the linea alba, reducing the risk of injury to the abdominal wall vasculature. Ultrasound, although a powerful tool, is imperfect in identifying abdominal wall vessels, evident by the persistent risk of hemorrhage associated with the conventional lateral approach.

More research is needed to determine the optimal approach to paracentesis. We believe these data are compelling to consider a midline approach to paracentesis in all patients.

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1 *Division of Pulmonary and Critical Care Medicine, University of Chicago Medical Center, Chicago, IL.*

2 *Division of Pulmonary, Allergy, and Critical Care Medicine, Washington University of St. Louis, St Louis, MO.*

3 *Division of Pulmonary and Critical Care Medicine, Columbia University, New York City, NY.*

4 *Virginia Tech Carilion School of Medicine, Roanoke, VA.*

5 *Mount Sinai Morningside/West, New York, NY.*

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Drs. Miller and Dinh are co-first authors.

For information regarding this article, E-mail: Josef.Miller3@gmail.com

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