Outcomes of iliac vein stents after pregnancy

Mohini Dasari, BS,[a] Efthimios Avgerinos, MD,[b] Seshadri Raju, MD,[c] Robert Tahara, MD,[d] *and* Rabih A. Chaer, MD,[b] *Pittsburgh and Bradford, Pa; and Jackson, Miss*

ABSTRACT

Objective: Stenting is the first-line treatment for obstructive iliocaval lesions when intervention is required. The aim of the study was to evaluate iliocaval stent patency during and after pregnancy in women of reproductive age who became pregnant after stent placement.

Methods: Female patients of reproductive age (18-45 years old) who underwent iliocaval stenting between May 2007 and March 2014 were identified from a three-center prospectively maintained database. Medical records were reviewed for demographics, baseline risk factors, operative data, and clinical follow-up to identify pregnancy and postpartum stent imaging. The primary end point was stent patency. Standard descriptive statistics were used.

Results: There were 310 women of reproductive age who received iliocaval stenting; 12 were identified to have had at least one pregnancy after stenting. The mean age was 28 ± 5 years. One patient received thrombolysis and stenting at 14 weeks of pregnancy for deep venous thrombosis (DVT) and May-Thurner syndrome, three for a previous postpartum DVT (2, 4, and 6 weeks postpartum), three for DVT before any pregnancy with a history of factor V Leiden, and the remaining five for unprovoked DVT. All stents were self-expanding with a diameter range of 14 to 16 mm. Mean time from stenting to pregnancy was 23.3 ± 28 months. All patients had patent stents during pregnancy and were prescribed therapeutic low-molecular-weight heparin by their obstetrician. One had asymptomatic left-sided stent compression 1 year after her second delivery, treated with balloon dilation. At average follow-up of 61 ± 56 months, all patients had patent stents with no ultrasound-identified structural damage or thrombosis.

Conclusions: Pregnancy does not negatively affect the outcomes of iliocaval stents after lysis of DVT or May-Thurner syndrome. Iliocaval stenting is not contraindicated in women of reproductive age, although close clinical and ultrasound follow-up is warranted during and after pregnancy. (J Vasc Surg: Venous and Lym Dis 2017;5:353-7.)

Stenting is the first-line treatment when intervention is required for chronic iliocaval obstruction or lesions uncovered after thrombolysis or thrombectomy of acute deep venous thrombosis (DVT).[1-4] Long-term outcomes of iliac venous stents are favorable and have been reported in multiple studies.[4-6]

Pregnant women are at a higher risk for development of venous thromboembolism (VTE) compared with nonpregnant women, with an estimated 1.1% incidence of DVT during pregnancy.[7] The risk for development of DVT during pregnancy is higher in the first two trimesters, and this risk continues to be increased in the puerperium compared with the antepartum period.[8] Prior history of thrombosis is the biggest risk factor for development of VTE in pregnancy, with an estimated 15% to 25% of VTE events in pregnancy being recurrent events.[9] In addition, about 10% of women with a prior VTE will develop recurrent VTE during pregnancy.[9] Consequently, the prevention of DVT, especially in women with a prior history of DVT, is of clinical importance.

Low-molecular-weight heparin (LMWH) has been shown to be safe and effective during and immediately after pregnancy for DVT prophylaxis in women with a history of acute DVT treated with catheter-directed thrombolysis.[10,11] One series demonstrated that LMWH thromboprophylaxis during pregnancy can lead to almost uneventful pregnancies in high-risk women without prior thrombolysis for DVT.[11] However, in this series, only about half of the women received adjunctive stenting; there have been no series examining women who become pregnant after undergoing both stenting and thrombolysis. Few studies have examined long-term stent patency in women who underwent iliac vein stenting and then became pregnant. One single-center series found no structural stent damage or DVT recurrence in women who previously underwent iliocaval stenting before pregnancy; however, this sample was relatively small and limited to 1-month follow-up of eight patients.[12]

From the University of Pittsburgh School of Medicine[a] and the Division of Vascular Surgery, University of Pittsburgh Medical Center,[b] Pittsburgh; The RANE Center for Venous and Lymphatic Diseases at St. Dominic, Jackson[c]; and the Allegheny Vein & Vascular Center, Bradford.[d]

Author conflict of interest: none.

Presented at the Thirtieth Annual Meeting of the Eastern Vascular Society, Philadelphia, Pa, September 15-17, 2016.

Correspondence: Rabih A. Chaer, MD, Professor of Surgery, Division of Vascular Surgery, University of Pittsburgh Medical Center, 200 Lothrop St, Ste A1011, Pittsburgh, PA 15213 (e-mail: chaerra@upmc.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2213-333X

http://dx.doi.org/10.1016/j.jvsv.2017.01.013

The aim of this study was to use a multicenter database to evaluate short-term (1-6 months) and midterm (>6 months) iliocaval stent patency in women of reproductive age who received iliac stenting and subsequently became pregnant. Given the concern for iliac stent thrombosis and compression by the gravid uterus amid the anatomic and coagulation changes of pregnancy, we wanted to examine whether pregnancies could occur with minimal complications after iliac vein stenting in women who had either a primary DVT or May-Thurner syndrome indication for stenting.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected data of a multicenter registry
- **Take Home Message:** Twelve of 310 women of reproductive age had at least one pregnancy after iliac vein stenting. One had asymptomatic stent compression after two deliveries, treated with balloon dilation. At average follow-up of 61 ± 56 months, all stents were patent without structural damage or thrombosis.
- **Recommendation:** The authors suggest that iliocaval stenting is not contraindicated in women of reproductive age, although close follow-up of this subset of patients is warranted.

METHODS

Female patients of reproductive age (18-45 years old) who underwent iliocaval stenting for thrombotic or nonthrombotic iliac vein disease between May 2007 and March 2014 were identified through a three-center prospectively maintained database. All three centers (Jackson, Miss, and Pittsburgh and Bradford, Pa) provide vascular surgery services that include clinical and imaging follow-up for the patients who underwent stenting. Pregnancy after stenting was identified through chart review and written or phone follow-up with patients to confirm details of pregnancy after stenting. Institutional Review Board approval was obtained at each participating center.

Medical records were reviewed for demographic information, including age, past medical history (including a history of any hypercoagulable state or prior DVT), and procedural data (including stent location, type, and diameter). All women were checked for a hypercoagulable state per their medical workup, including factor V Leiden and other hereditary and acquired causes of hypercoagulability, as well as the presence of any risk factors (oral contraceptive pill use, smoking). Postpartum stent ultrasound imaging and vascular clinical evaluations were reviewed to ascertain stent patency and clinical symptoms of recurrence. Other variables recorded in the database included the following: indication for intervention; risk factors for DVT; anticoagulation status before intervention; antiplatelet therapy; total number of pregnancies; pregnancies after the procedure; location of DVT; Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) class; side and approach for thrombolysis; balloon size; stent type; and postoperative complications.

Postpartum stent patency data were collected up until the last date of available follow-up. The primary end point was stent patency, with the secondary outcome of interest being the development of any stent-related or thrombotic complications as well as reinterventions during or after pregnancy. Women were not routinely undergoing venous duplex ultrasound scans during their pregnancies unless there was clinical concern for stent compression, and this was not standardized among the sites as pregnancies often took place at other health care systems. Postpartum clinical and ultrasound follow-up was performed per clinical practice of the provider at any of the three included institutions and did not follow a specified study protocol. No other radiologic studies were performed routinely postpartum to determine stent integrity. All vascular laboratories were Intersocietal Accreditation Commission certified. The interpreting physicians are vascular surgeons at the respective centers and hold an RVT certificate, RPVI certificate, or both. Not all sites used the same criteria for making the diagnosis because there are no established criteria to determine in-stent stenosis. Data were summarized using standard descriptive statistics. Informed consent of the patients was not required or obtained because of the deidentified review nature of the study.

RESULTS

A total of 310 reproductive-age female patients were included from each center: RANE Center (n = 267), Pittsburgh (n = 27), and Bradford (n = 16). Of these women, a total of 12 patients became pregnant: RANE Center (n = 7), Pittsburgh (n = 4), and Bradford (n = 1). These 12 women (4%) were identified by clinical chart review and phone or written follow-up to have become pregnant at least once after stenting. All had stenting for either a thrombotic or nonthrombotic indication. All stents were self-expanding with a diameter range of 14 to 16 mm. The mean time from stenting to pregnancy was 23.3 ± 28 months. The median follow-up time after pregnancy was 20 months (range, 2-98 months). Of these 12 women, 4 had short-term (1-6 months) and 8 had midterm (>6 months) postpartum follow-up.

Patient demographics, clinical history, stent location, pregnancy outcomes, and complications are outlined in the Table. The mean age of the studied cohort patients was 28 ± 5 years. One patient received thrombolysis and stenting during pregnancy for DVT and May-Thurner syndrome, three for a previous postpartum DVT, three for DVT before any pregnancy with a history

Table. Patient demographics and outcomes

No.	Age at first procedure, years	DVT vs MTS	Hypercoagulable state	Stent location	No. of pregnancies after stent placement	Time to first pregnancy after stent, months	No. of stents	Stent sizes	Stent brand	Stent status	Months from delivery to last radiographic follow-up[a]
1	26	DVT	No	CIV/EIV	1	12	1	14	Protege	Normal	2
2	28	DVT	No	CIV/EIV	1	2	1	16	Wallstent	Normal	13
3	22	DVT	Factor V Leiden	CIV/EIV	1	12	2	14, 14	Protege	Normal	8
4	20	DVT	No	CIV/iliocaval junction	1	27	1	14	Protege	Normal	4
5	31	MTS	No	CIV/EIV	1	3	1	14	Wallstent	Normal	18
6	25	DVT	No	CIV/EIV/ femoral vein	2	36	1	16	Protege	Asymptomatic stent compression 1 year after second delivery	98
7	39	DVT	No	CIV/EIV/ femoral vein	1	12	1	14	Protege	Normal	4
8	33	DVT	No	CIV/EIV/ femoral vein	1	108	1	14	Protege	Normal	21
9	27	DVT	Factor V Leiden	CIV/iliocaval junction	1	12	1	16	Wallstent	Normal	3
10	27	DVT	No	CIV/EIV	3	14	1	14	Protege	Normal	96
11	29	DVT	No	CIV/EIV	1	17	1	14	Wallstent	Normal	37
12	29	DVT	Factor V Leiden	CIV/EIV/ femoral vein	1	24	1	16	Protege	Normal	49

CIV, Common iliac vein; *DVT,* deep venous thrombosis; *EIV,* external iliac vein; *MTS,* May-Thurner syndrome.
[a]All radiographic follow-up studies were venous ultrasound studies.

of factor V Leiden, and the remaining five for unprovoked DVT. All patients were receiving prophylactic LMWH during their pregnancy, and all stents remained patent. None of the patients experienced DVT or symptomatic pulmonary embolism during their pregnancies, and none had a spontaneous abortion. At a median follow-up of 63 months (range, 24-143 months) after initial stenting, all patients remained asymptomatic with patent stents. One patient developed left-sided stent compression/stenosis 1 year after her second delivery, which was a novel finding identified on routine ultrasound surveillance. This was successfully treated with balloon dilation, and subsequent 3-month clinical and ultrasound follow-up was unremarkable.

DISCUSSION

Iliocaval DVT lesions in women of reproductive age often require thrombolytic therapy with iliocaval stenting.[13] This, along with iliac vein stenting for a nonthrombotic indication, raises the concern in these young patients of stent failure or structural damage during subsequent pregnancies. To our knowledge, this case series is currently the largest and only multicenter series to report the long-term and postpartum outcomes of women who received iliac stenting for venous thrombotic or nonthrombotic indications. There were no instances of DVT recurrence, symptomatic pulmonary embolism, or stent occlusion. Only one patient demonstrated asymptomatic stent compression 1 year postpartum, which was successfully treated with balloon dilation.

Five of the 12 women in this series experienced an unprovoked DVT that was treated with stenting. Stenting was deemed necessary in those patients because of residual iliac vein lesions identified on ascending venography or intravenous ultrasound that were believed to lead to a high rate of rethrombosis if left untreated.[14] Whereas the long-term outcomes of iliac vein stents in younger patients are not well defined, iliac vein stenting is recommended by the current guidelines to treat iliac vein lesions identified after thrombolysis to prevent recurrent DVT. The stents generally inserted are large in diameter (14, 16, or 18 mm), and given that venous blood pressures are lower than arterial pressures, such iliocaval stents are more likely to last for a longer time even when inserted in young patients.

The theoretical and observed concern for structural damage to iliocaval stents during pregnancy is related to the both anatomic and physiologic changes that

occur during pregnancy. The pressure of the gravid uterus on the iliac veins and the known relative venous stasis that occurs during pregnancy are considerations for potential stent complications in this anatomic region. In addition, changes in coagulation factors during pregnancy are well established and mechanistically can contribute to stent complications. All of the stents in this series were self-expanding, with limited radial strength. Although they may be compromised, given the inward force on the veins during pregnancy by the gravid uterus, they are expected to re-expand after delivery and relief of the extrinsic compression. This cohort includes a relatively young group of women, and no data are available to document the safety of these stents on an extremely long-term basis.

The findings of our study mirror some of the findings of a previous case series examining iliac stent patency after pregnancy.[12] This study adds to the existing literature, given that we were able to analyze a larger cohort of patients from a prospectively maintained, multicenter database, with longer follow-up, thereby including patients treated by a variety of providers in different locations, thus representing a more heterogeneous sample.

In our series, not all women were maintained on anticoagulation before and after pregnancy, except for the three women with a history of factor V Leiden. The rest were not anticoagulated before and after pregnancy. Five of the 12 patients were routinely maintained on a therapeutic aspirin dose of 81 mg/d before pregnancy. All women were receiving LMWH during their pregnancies; none were taking warfarin during pregnancy. In terms of being able to undergo multiple pregnancies, two of the patients in our series carried through multiple successful pregnancies after stenting (two and three, respectively), and clinical and ultrasound follow-up was obtained through the last pregnancies, suggesting that multiple pregnancies are possible after iliac vein stenting, without any demonstrable adverse events.

One of the most relevant issues related to clinical practice raised by this and prior studies is how follow-up should be conducted for stents placed before pregnancy in women of reproductive age. As this series highlighted, the one instance of stent compression occurred 1 year postpartum following the patient's second pregnancy after stenting. This compression was asymptomatic but was not previously seen on ultrasound surveillance and would likely not have been identified if not for routine follow-up. Whereas there are no clear guidelines on the need for ultrasound follow-up postpartum in women who have an iliac vein stent, this practice seems prudent, given the potential for intrapartum stent compression and eventual thrombosis either at a later date or during a subsequent pregnancy. Further studies with standardized lengths of clinical and radiologic follow-up are needed to ascertain the usefulness and frequency of surveillance.

This study is not without limitations. This is a small series and hence is not powered to conduct robust analyses. Nonetheless, this is the first multicenter study to examine postpartum outcomes of women with an existing iliac vein stent for thrombotic or nonthrombotic iliac vein occlusion.

CONCLUSIONS

Pregnancy does not seem to negatively affect the patency and structural outcomes of iliocaval stents for thrombotic or nonthrombotic iliac vein occlusion. Iliocaval stenting is not contraindicated in women of reproductive age, although clinical and ultrasound follow-up may be warranted postpartum to evaluate stent patency and compression. This case series demonstrated good short-term and midterm outcomes through pregnancy in patients treated with iliocaval stenting for venous thrombotic or nonthrombotic occlusive disease.

AUTHOR CONTRIBUTIONS

Conception and design: EA, SR, RT, RC
Analysis and interpretation: MD, EA, SR, RT, RC
Data collection: EA, SR, RT
Writing the article: MD, EA
Critical revision of the article: MD, EA, SR, RT, RC
Final approval of the article: MD, EA, SR, RT, RC
Statistical analysis: MD
Obtained funding: Not applicable
Overall responsibility: MD

REFERENCES

1. Mussa FF, Peden EK, Zhou W, Lin PH, Lumsden AB, Bush RL. Iliac vein stenting for chronic venous insufficiency. Tex Heart Inst J 2007;34:60-6.
2. Xue GH, Huang XZ, Ye M, Liang W, Zhang H, Zhang JW, et al. Catheter-directed thrombolysis and stenting in the treatment of iliac vein compression syndrome with acute iliofemoral deep vein thrombosis: outcome and follow-up. Ann Vasc Surg 2014;28:957-63.
3. Park JY, Ahn JH, Jeon YS. Iliac vein stenting as a durable option for residual stenosis after catheter-directed thrombolysis and angioplasty of iliofemoral deep vein thrombosis secondary to May-Thurner syndrome. Phlebology 2014;29:461-70.
4. Hartung O, Benmiloud F, Barthelemy P, Dubuc M, Boufi M, Alimi YS. Late results of surgical venous thrombectomy with iliocaval stenting. J Vasc Surg 2008;47:381-7.
5. Neglen P, Hollis KC, Olivier J, Raju S. Stenting of the venous outflow in chronic venous disease: long-term stent-related outcome, clinical and hemodynamic result. J Vasc Surg 2007;46:979-90.
6. Hartung O, Otero A, Boufi M, De Caridi G, Barthelemy P, Juhan C, et al. Mid-term results of endovascular treatment for symptomatic chronic nonmalignant iliocaval venous occlusive disease. J Vasc Surg 2005;42:1138-44.
7. Meng K, Hu X, Peng X, Zhang Z. Incidence of venous thromboembolism during pregnancy and the puerperium: a systematic review and meta-analysis. J Matern Fetal Neonatal Med 2015;28:245-53.
8. Ray JG, Chan WS. Deep vein thrombosis during pregnancy and the puerperium: a meta-analysis of the period of risk

and the leg of presentation. Obstet Gynecol Surv 1999;54:265-71.
9. Pabinger I, Grafenhofer H, Kyrle PA, Quehenberger P, Mannhalter C, Lechner K, et al. Temporary increase in the risk for recurrence during pregnancy in women with a history of venous thromboembolism. Blood 2002;100:1060-2.
10. Greer IA, Nelson-Percy C. Low-molecular-weight heparins for thromboprophylaxis and treatment of venous thromboembolism in pregnancy: a systematic review of safety and efficacy. Blood 2005;106:401-7.
11. Jørgensen M, Broholm R, Bækgaard N. Pregnancy after catheter-directed thrombolysis for acute iliofemoral deep vein thrombosis. Phlebology 2013;28(Suppl 1):34-8.
12. Hartung O, Barthelemy P, Amoux D, Boufi M, Alimi YS. Management of pregnancy in women with previous left ilio-caval stenting. J Vasc Surg 2009;50:355-9.
13. Hager ES, Yuo T, Tahara R, Dillavou E, Al-Khoury G, Marone L, et al. Outcomes of endovascular intervention for May-Thurner syndrome. J Vasc Surg Venous Lymphat Disord 2013;1:270-5.
14. Kölbel T, Lindh M, Holst J, Uher P, Eriksson KF, Sonesson B, et al. Extensive acute deep vein thrombosis of the iliocaval segment: midterm results of thrombolysis and stent placement. J Vasc Interv Radiol 2007;18:243-50.

Submitted Oct 3, 2016; accepted Jan 25, 2017.