

Surgical Management of a Torn ACL and Bucket-Handle Meniscal Tear in the Pregnant Patient

A Case Report

Peter Filtes, PharmD, Mark A. Beckerman, MD, Kimberlee Austin, MD, Patrick S. Buckley, MD, and Kenneth G. Swan Jr., MD

Investigation performed at Rutgers, Robert Wood Johnson Medical School, Department of Orthopaedic Surgery, New Brunswick, New Jersey

Abstract

Case: A 36-year-old, 7-month pregnant woman presented to the office with a locked knee and a displaced bucket-handle medial meniscus tear, in the setting of chronic anterior cruciate ligament (ACL) insufficiency. After thorough discussion with the patient and her husband, the obstetrician, and the anesthesiologist, the patient was treated with left knee ACL reconstruction and medial meniscus repair.

Conclusion: With sufficient preoperative planning and coordinated multidisciplinary care among orthopaedic, anesthesiologist, and obstetric specialists, elective knee surgery can be performed safely in time-sensitive situations during pregnancy.

A bucket-handle meniscal tear (BHMT) is a vertical longitudinal tear that can be displaced toward the intercondylar notch, often presenting with a locked knee¹. A displaced BHMT represents a surgical urgency because the injury is more amenable to treatment and often prevents full knee extension making ambulation difficult¹. However, pregnancy complicates management of these injuries and can be an important consideration to delay treatment. Elective surgical procedures are typically deferred in pregnant patients^{2,3}; however, there is little guidance on the management of an acute BHMT in a pregnant patient. The only published report on the management of a locked knee during pregnancy includes 2 patients: 1 with a bucket-handle meniscus tear and 1 with a loose body. Both patients underwent surgery using spinal anesthesia, without harm to the patient or fetus⁴. In addition, in patients with chronic anterior cruciate ligament (ACL) insufficiency, repair of acute BHMT supports concurrent anterior cruciate ligament (ACL) reconstruction to prevent future meniscus re-tear and knee instability.

We present a case of an acute BHMT diagnosed in a 36-year-old pregnant patient at 26 weeks' gestation with a known 5-year history of chronic ACL insufficiency, who underwent meniscus repair and ACL reconstruction.

The patient was informed that data concerning the case would be submitted for publication, and she provided consent.

Case Report

A 36-year-old pregnant patient at 26 weeks' gestation presented with a locked knee after minor trauma. Five years

earlier, she tore her ACL, which she elected to treat nonoperatively. Physical examination and MRI were consistent with an acute bucket-handle medial meniscus tear and a chronically torn ACL (Fig. 1). The treatment options for this patient included nonoperative treatment, postpartum surgery, and surgery before delivery. Surgical options included meniscus repair vs meniscectomy, as well as ACL reconstruction vs benign neglect of the chronic ACL tear. Given the significant loss of extension affecting ambulation and the patient's young age, we recommended a knee arthroscopy and medial meniscus repair, if possible. If the meniscus was to be repaired, the ACL would then require reconstruction, to maintain stability and give the meniscus the best chance to heal. The above-mentioned treatment options and associated perioperative risks, especially the risk of deep vein thrombosis (DVT)/pulmonary embolism in this pregnant patient, were discussed at length with the patient and her husband. We recommended allograft reconstruction to limit the postoperative pain and ease recovery after surgery. The patient's obstetrician recommended that we proceed as we normally would in a nonparturient, treating this knee accordingly. She recommended spinal anesthesia and the use of unfractionated heparin (UFH) for DVT prophylaxis postoperatively.

Ultrasound-guided adductor canal block was performed preoperatively with ropivacaine. In the operating room, spinal anesthetic was administered with bupivacaine and 20 mcg of fentanyl. Clindamycin was given for antibiotic prophylaxis. Examination under anesthesia revealed a positive Lachman test (3B) and a positive Grade III pivot shift. The knee lacked

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJS/CC321>).

Keywords Bucket-handle meniscal tear; Chronic ACL insufficiency; locked knee; ACL reconstruction; pregnant female; all-inside meniscus repair; peroneus allograft; orthopaedics; anesthesiology; obstetrics

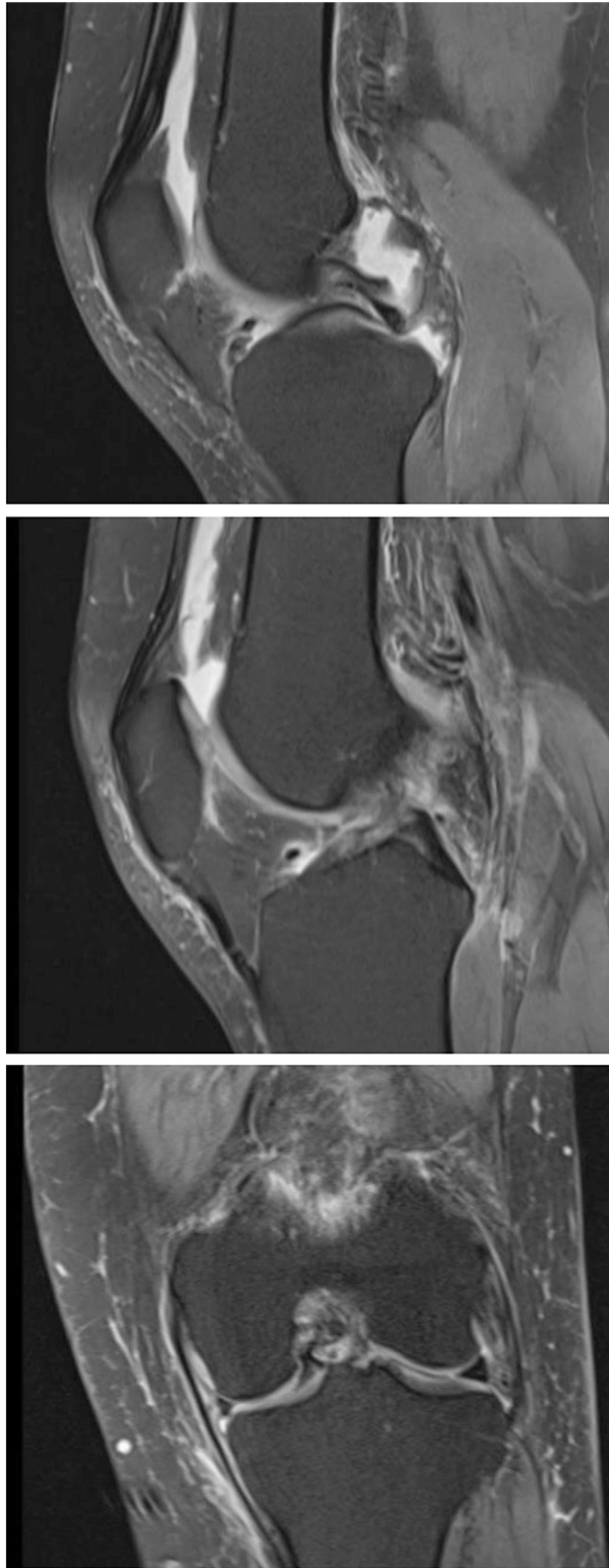


Fig. 1

MRI L knee at initial presentation (26 weeks' gestation). **Fig. 1-A** T2 sagittal MRI showing “double Posterior Cruciate Ligament” sign of displaced bucket-handle medial meniscus tear. **Fig. 1-B** T2 sagittal MRI showing chronic ACL tear. **Fig. 1-C** T2 coronal MRI showing displaced bucket-handle medial meniscus tear.

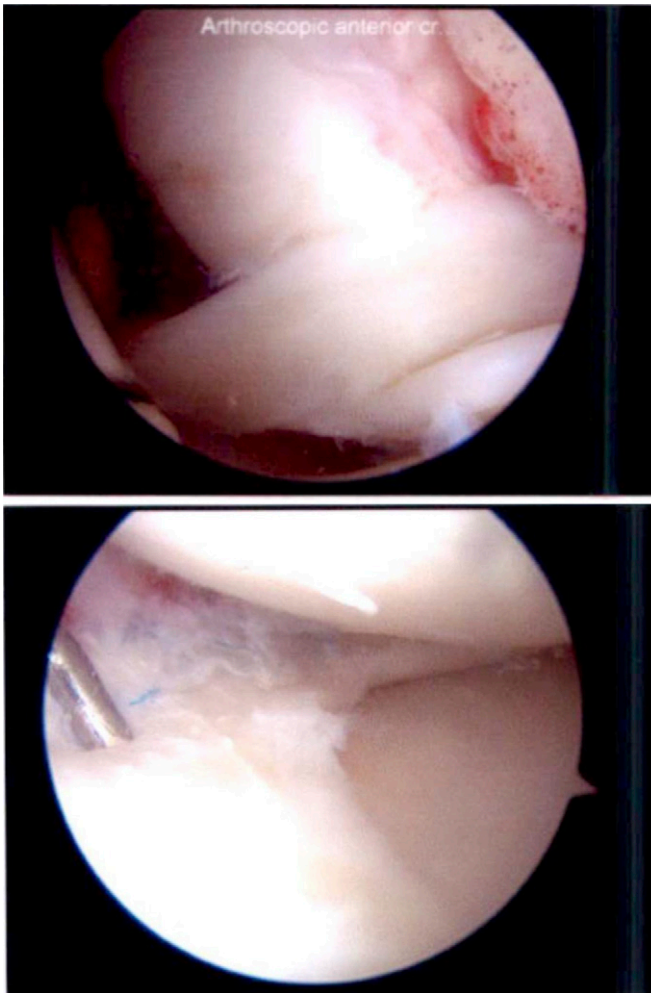


Fig. 2
Intraoperative arthroscopic images: meniscus. **Fig. 2-A** Displaced BMHT. **Fig. 2-B** Repair of BMHT. BMHT = bucket-handle meniscus tear.

approximately 15° of extension. A standard arthroscopy ensued. Diagnostic arthroscopy revealed a large, displaced bucket-handle medial meniscus tear and a torn ACL. The chondral surfaces and lateral meniscus were healthy and intact. The medial meniscus was of healthy quality and was easily reducible, and the decision was made to repair the meniscus. Five all-inside meniscus repair devices (Fast-Fix) were used for an all-inside technique with vertical mattress sutures to repair this meniscus (Fig. 2).

A standard allograft ACL reconstruction was performed with peroneus allograft (MTF Biologics) (Fig. 3). Cortical button fixation was used on the femur and interference screw fixation on the tibia. Postoperatively, she was placed in a knee immobilizer and made non-weight-bearing for 3 weeks and would start therapy the following week. Before discharge, the patient went to the Obstetrics suite for fetal monitoring as per obstetrician recommendations. The mother and fetus were deemed stable for discharge. The patient was given Percocet for pain control, instructed not to use any nonsteroidal anti-inflammatory (NSAIDs), and started on 4 weeks of UFH for DVT prophylaxis

the following day. She began physical therapy at postop week 1, following normal protocol. At 3 months postoperative, the patient gave birth to a healthy full-term baby boy without complication. The physical therapy schedule was adjusted to accommodate the perinatal period, but compliance with ongoing therapy was established and the patient completed a full course after giving birth. At the 4.5-month follow-up, she demonstrated full range of motion, and Lachman test (1A) demonstrated full stability. At final follow-up of 12 months, the patient had full active and passive range of motion, a stable Lachman test (1A), and no tenderness medially.

Discussion

A torn meniscus is a time-sensitive problem in a patient presenting with a “locked knee,” which is noted on physical examination by an inability to fully extend the knee. It is well established that there is a significantly lower ability to perform a meniscus repair as time from injury progresses. In addition, long-term studies have shown significantly better clinical outcomes when the menisci are repaired simultaneously at the time of ACL reconstruction (ACLR)⁵⁻⁷. Proposed explanations for this include more extensive and consistent rehabilitation protocols associated with ACLR, expanded hemarthrosis with fibrin clot formation, increased biological healing secondary to release of marrow elements into the joint from tunnel drilling, and the added benefit of the knee stability in an ACL reconstructed knee⁸⁻¹¹. Based on this literature, there were numerous indications for surgical treatment of our patient with an acute BHMT, evidence of a locked knee, and concurrent chronic ACL insufficiency. Given her young age, our preference was for meniscus repair and preservation and concomitant ACL reconstruction to protect the repair. Although this patient had a baseline risk of further knee injury, given her history of chronic ACL insufficiency, it is also possible that pregnancy was a secondary risk. Several physiologic changes that occur in pregnancy contribute to this risk including increased body weight, ligament laxity from hormone levels, alterations in activity level and strength, and various hormonal changes¹²⁻¹⁵.

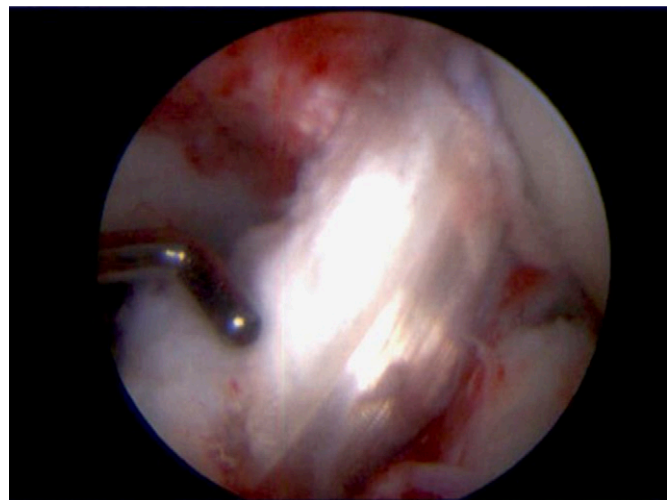


Fig. 3
Intraoperative arthroscopic images: ACL reconstruction.

TABLE I Anesthetic Concerns for Nonobstetric Surgery During Pregnancy

Anesthetic Concern	Description
Maternal safety	Physiological changes of pregnancy Conditions compelling surgery
Fetal safety	Placental transfer of drugs Teratogenicity <ul style="list-style-type: none"> ● Timing of exposure ● Duration/dosage of exposure ● FDA pregnancy category ● Individual anesthetic drugs Maternal factors leading to fetal compromise <ul style="list-style-type: none"> ● Maternal hypoxia ● Maternal hypercarbia/hypocarbica ● Changes in uterine blood flow

FDA = Food and Drug Administration.

To assess the appropriateness of surgery for our pregnant patient, we had to weigh the benefits of performing the elective surgery against the potential risks to the mother and/or fetus while also accounting for the potential disadvantages of postponing treatment. Pregnancy complicates the decision to perform any surgical procedure as several issues must be addressed beforehand but are not commonplace for the orthopaedic surgeon to manage. Previous studies analyzing surgical anesthesia during pregnancy and correlated fetal outcomes support delaying any purely elective surgery until the postpartum period^{2,3}. However, the urgency of a locked knee, the risk of DVT because of immobilization of the mother, and its potential effect during the delivery of the fetus created a distinctive clinical predicament for the operative team. In preparation for this case, there was a multidisciplinary discussion between orthopaedic surgery, anesthesia, and obstetrics regarding multiple facets of her care.

These decisions (highlighted in Table I) became paramount as our patient was entering the third trimester—a time when surgical intervention comes with increased risk of preterm delivery, placental abruption, and perinatal mortality. Relatedly, 5 major international studies have attempted to correlate general anesthesia (GA) during human pregnancy with congenital anomalies, neurocognitive effects, or intrauterine demise—but as of now there have been no such findings¹⁶. Nevertheless, regional anesthesia has become the preferred technique in these scenarios because GA is associated with a greater risk of pulmonary aspiration, hemodynamic fluctuation during induction, and overall maternal morbidity. With the additional benefit of using spinal opioids for postoperative pain relief and no current evidence of local anesthetic teratogenicity in peripheral nerve blockade, the choice of primary neuraxial anesthesia and single shot adductor canal block became quite favorable¹⁷.

Regarding nonobstetric surgery, the American College of Obstetricians and Gynecologists' (ACOG) Committee on Obstetric Practice recommends that “a pregnant woman should never be denied medically necessary surgery or have surgery delayed regardless of trimester because this can adversely affect the pregnant woman and her fetus”¹⁸. However, timing of non-elective surgery for the pregnant patient is ideally the second trimester. This minimizes exposure of fetus to not just the surgery but medications during the period of organogenesis, which occurs through first 12 weeks of pregnancy. The gravid uterus in the third trimester can make positioning and the surgical procedure itself more technically difficult. In addition, data suggest the risk of preterm labor may be lower when performed in the second trimester¹⁹. ACOG also published recommendations regarding maternal safety, and fetal safety in nonobstetric surgery during pregnancy, summarized in Table II¹⁸. Therefore, the choice of anesthetic technique and the selection of appropriate medications for anesthesia are guided by maternal indications for surgery and the location of the surgical procedure¹⁸. Given these considerations, our patient underwent spinal anesthesia for her procedure.

As with any patient undergoing meniscal repair and ACLR, there was a need for perioperative antibiotics, DVT

TABLE II ACOG Recommendations on Nonobstetric Surgery During Pregnancy¹⁹

Concern	Recommendation
Maternal safety	Pregnant women undergoing nonobstetric surgery should be screened for venous thromboembolism risk and should have the appropriate perioperative prophylaxis administered
Fetal safety	No currently used anesthetic agents have been shown to have any teratogenic effects in humans when using standard concentrations at any gestational age There is no evidence that in utero human exposure to anesthetic or sedative drugs has any effect on the developing fetal brain, and there are no animal data to support an effect with limited exposures less than 3 h in duration If the fetus is considered previable, it is sufficient to ascertain the fetal heart rate by Doppler before and after the procedure At a minimum, if the fetus is viable, simultaneous electronic fetal heart rate and contraction monitoring should be performed before and after the procedure to assess fetal well-being and the absence of contractions

ACOG = American College of Obstetricians and Gynecologists.

TABLE III FDA Pregnancy Categories²²⁻²⁴

Medication	FDA Pregnancy Category
Clindamycin ²²	FDA pregnancy category B: Animal reproduction studies have failed to demonstrate a risk to the fetus, and there are no adequate and well-controlled studies in pregnant women ¹⁹ .
Unfractionated heparin ²³	FDA pregnancy category B: Animal reproduction studies have failed to demonstrate a risk to the fetus, and there are no adequate and well-controlled studies in pregnant women ²⁰ .
Oxycodone-acetaminophen ²⁴	FDA pregnancy category C: Animal reproduction studies have shown an adverse effect on the fetus, and there are no adequate and well-controlled studies in humans, but potential benefits may warrant use of the drug in pregnant women, despite potential risks ²¹ .
FDA = Food and Drug Administration	

prophylaxis postop, and a postop pain regimen. Pregnancy poses additional risks of venous thromboembolism (VTE) because of a physiologic hypercoagulable state²⁰. For this reason, the European guidelines on perioperative VTE prophylaxis recommend thromboprophylaxis after surgery during pregnancy if a procedure consequently necessitates bed rest, until full mobility is recovered²¹. We used clindamycin perioperatively because our patient had a PCN allergy. The patient was discharged with UFH for VTE prophylaxis for a duration of 4 weeks and Percocet for pain management. Our choices for medications involved assessment of the literature for evidence-based recommendations for efficacy, any possible harm to the mother and/or fetus, as well as Food and Drug Administration (FDA) pregnancy categories (Table III)²²⁻²⁴. The ACOG recommends heparin compounds as the preferred agents for VTE prophylaxis during pregnancy²⁵. We also advised our patient against use of any NSAIDs medications as the FDA advises against the use of NSAIDs around 20 weeks or later in pregnancy because this class of medications may cause rare but serious kidney complications in an unborn fetus as well as an increased risk of premature closure of fetal ductus arteriosus and oligohydraminos²⁶.

Additional perioperative fetal considerations include the decision to use continuous, intermittent, or prefetal and postfetal heart rate monitoring. Several factors including gestational age, availability of obstetrical and neonatal services, type and length of surgery, and type of anesthesia will all play a role in the choice to use fetal heart rate monitoring. The general consensus is if the fetus is previsible, fetal heart rate documentation by Doppler is sufficient before and after procedure. If the fetus is considered viable, electronic fetal heart rate and contraction monitoring should be performed at the bare minimum before and after procedure. Intraoperative electronic fetal monitoring may be appropriate only when all of the following conditions are met—the fetus is viable, intraoperative monitoring is physically

possible, obstetrics is available to intervene if needed, and the nature of the surgery will allow for safe interruption to perform an emergency delivery.

Conclusion

Bucket-handle meniscal tears in the setting of chronic ACL insufficiency represent a surgical urgency. Nevertheless, pregnancy complicates the decision to pursue acute management of these injuries and can be an important consideration to delay treatment. Special considerations must be given to the indications for surgical intervention, anesthetic options, perioperative antibiotic use, and postoperative VTE prophylaxis and pain management in the pregnant patient. With sufficient preoperative planning and coordinated multidisciplinary care among orthopaedic, anesthesiologist, and obstetric specialists, elective knee surgery can be performed safely in time-sensitive situations during pregnancy. ■

Peter Filtes, PharmD¹
Mark A. Beckerman, MD²
Kimberlee Austin, MD³
Patrick S. Buckley, MD¹
Kenneth G. Swan Jr., MD¹

¹Department of Orthopaedics, Rutgers, Robert Wood Johnson Medical School, New Brunswick, New Jersey

²Department of Anesthesiology, Icahn School of Medicine at Mount Sinai, New York City, New York

³Department of Obstetrics and Gynecology, Atlantic Health, Morristown Memorial Hospital, Morristown, New Jersey

E-mail address for K.G. Swan: kage2336@gmail.com

References

1. Ardizzone CA, Houck DA, McCartney DW, Vidal AF, Frank RM. All-inside repair of bucket-handle meniscal tears: clinical outcomes and prognostic factors. *Am J Sports Med.* 2020;48(13):3386-93.
2. Steinberg ES, Santos AC. Surgical anesthesia during pregnancy. *Int Anesthesiol Clin.* 1990;28:58-66.
3. Brodsky JB, Cohen EN, Brown BW Jr, Wu ML, Whitcher C. Surgery during pregnancy and fetal outcome. *Am J Obstet Gynecol.* 1980;138:1165-7.
4. Flik K, Anderson K, Urme W, Wickiewicz T. Locked knee during pregnancy. *Arthroscopy.* 2004;20(2):191-5.
5. Nishida M, Higuchi H, Kobayashi Y, Takagishi K. Histological and biochemical changes of experimental meniscus tear in the dog knee. *J Orthop Sci.* 2005;10(4):406-13.
6. Pujol N, Barbier O, Boisrenoult P, Beaufile P. Amount of meniscal resection after failed meniscal repair. *Am J Sports Med.* 2011;39(8):1648-52.

- 7.** Toman CV, Dunn WR, Spindler KP, Amendola A, Andrich JT, Bergfeld JA, Flanigan D, Jones MH, Kaeding CC, Marx RG, Matava MJ, McCarty EC, Parker RD, Wolcott M, Vidal A, Wolf BR, Huston LJ, Harrell FE Jr, Wright RW. Success of meniscal repair at anterior cruciate ligament reconstruction. *Am J Sports Med.* 2009;37:1111-5.
- 8.** Henning CE, Lynch MA, Yearout KM, Vequist SW, Stallbaumer RJ, Decker KA. Arthroscopic meniscal repair using an exogenous fibrin clot. *Clin Orthop Relat Res.* 1990;252:64-72.
- 9.** Henning CE, Yearout KM, Vequist SW, Stallbaumer RJ, Decker KA. Use of the fascia sheath coverage and exogenous fibrin clot in the treatment of complex meniscal tears. *Am J Sports Med.* 1991;19:626-31.
- 10.** Freedman KB, Nho SJ, Cole BJ. Marrow stimulating technique to augment meniscus repair. *Arthroscopy.* 2003;19:794-8.
- 11.** Stärke C, Kopf S, Petersen W, Becker R. Meniscal repair. *Arthroscopy.* 2009;25:1033-44.
- 12.** Ostgaard HC, Andersson GB, Schultz AB, Miller JA. Influence of some biomechanical factors on low-back pain in pregnancy. *Spine.* 1993;18:61-5.
- 13.** Calguneri M, Bird HA, Wright V. Changes in joint laxity occurring during pregnancy. *Ann Rheum Dis.* 1982;41(2):126-8.
- 14.** O'Byrne EM, Carriere BT, Sorensen L, Segaloff A, Schwabe C, Steinetz BG. Plasma immunoreactive relaxin levels in pregnant and nonpregnant women. *J Clin Endocrinol Metab.* 1978;47:1106-10.
- 15.** Dumas GA, Reid JG. Laxity of the knee cruciate ligaments during pregnancy. *J Orthop Sports Phys Ther.* 1997;26:2-6.
- 16.** Fisher SC, Siag K, Howley MM, Van Zutphen AR, Reefhuis J, Browne ML. National birth defects prevention study: maternal surgery and anesthesia during pregnancy and risk of birth defects in the national birth defects prevention study, 1997-2011. *Birth Defects Res.* 2020;112(2):162-74.
- 17.** Barash PG, Cullen BF, Stoelting RK, Cahalan MK, Stock MC, Ortega R. *Clinical Anesthesia.* 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2013.
- 18.** ACOG Committee Opinion No. 775: Nonobstetric surgery during pregnancy. *Obstet Gynecol.* 2019;133(4):e285-e286.
- 19.** Fatum M, Rojansky N. Laparoscopic surgery during pregnancy. *Obstet Gynecol Surv.* 2001;56:50.
- 20.** James AH. Venous thromboembolism in pregnancy. *Arterioscler Thromb Vasc Biol.* 2009;29(3):326-31.
- 21.** Ducloy-Bouthors A, Baldini A, Abdul-Kadir R, Nizard J. European guidelines on perioperative venous thromboembolism prophylaxis. *Eur J Anaesthesiol.* 2018;35(2):130-3.
- 22.** Clindamycin [monograph]. In: Lexicomp Online [online database]. Hudson, OH: Lexi-Comp; 2022.
- 23.** Unfractionated heparin [monograph]. In: Lexicomp Online [online database]. Hudson, OH: Lexi-Comp; 2022.
- 24.** Oxycodone-acetaminophen [monograph]. In: Lexicomp Online [online database]. Hudson, OH: Lexi-Comp; 2022.
- 25.** James A. Committee on Practice bulletins—obstetrics Practice bulletin no. 123: thromboembolism in pregnancy. *Obstet Gynecol.* 2011;118(3):718-29.
- 26.** FDA Drug Safety Communication: FDA Recommends Avoiding Use of NSAIDs in Pregnancy at 20 Weeks or Later Because They Can Result in Low Amniotic Fluid. 2020;e1-e8.