

A Comprehensive Multidisciplinary Strategy for the Management of Musculoskeletal Fractures Throughout Pregnancy: Evaluation, Treatment, and Maternal-Fetal Considerations

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Abstract

Because of physiological, anatomical, and pharmacological changes that impact diagnostic and treatment strategies, pregnancy-related fractures pose special difficulties. Prioritizing the safety of the mother and fetus necessitates interdisciplinary teamwork. The purpose of this review is to investigate current understanding and recommended practices for multidisciplinary fracture therapy during pregnancy, with a focus on diagnostic safety, treatment options, and maternal-fetal outcomes. Case reports, clinical recommendations, and pertinent reviews were included in a narrative evaluation of the body of available literature. In the context of pregnancy, the analysis addressed surgical decision-making, postpartum care, anesthetic concerns, and diagnostic imaging modalities. Pregnancy-related physiological alterations that impact trauma treatment include increased blood volume, ligamentous laxity, and altered medication metabolism. Diagnostic imaging techniques like MRI and ultrasound are thought to be safe, although they may provide dangers to the fetus. When surgery is required, gestational age must be taken into account; for non-emergency surgeries, the second trimester is favored. For the best results, a multidisciplinary team that includes neonatologists, obstetricians, orthopedic surgeons, and anesthesiologists is essential. When possible, regional anesthesia is preferred over general anesthesia. Fetal monitoring and thromboprophylaxis are part of postoperative care. A coordinated, multidisciplinary strategy is necessary to efficiently manage fractures in pregnant women while striking a balance between the requirements of the mother and the safety of the fetus. In order to minimize difficulties and guarantee positive results for both mother and child, early preparation, risk assessment, and customized treatment are essential.

Keywords: *Obstetric Anesthetic, Trauma, Multidisciplinary Treatment, Maternal-Fetal Health, And Pregnancy Fractures.*

Introduction

Trauma, defined as harm induced by external forces, is one of the top non-obstetric causes of maternal death during pregnancy (1). Trauma, particularly orthopedic trauma, is defined as a serious damage to the musculoskeletal or locomotor systems in the context of orthopedic medicine (2). Physical trauma complicates roughly one out of every twelve pregnancies (3), with the most common causes being motor vehicle accidents, falls, and interpersonal violence (4). These episodes pose a significant concern, with severe maternal trauma associated with fetal death rates of up to 40% to 50%, underscoring the vital need

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for urgent and specialist care for both mother and baby (1). This dual-patient obligation makes caring for pregnant trauma victims one of the most difficult responsibilities for nursing as well as medical personnel.

Pregnancy causes a variety of physiological changes that make it more difficult to diagnose and treat injuries. One such alteration is a rise in blood volume, which begins around the sixth week of gestation and peaks around the 32nd week. As a result, pregnant women may not have normal hemodynamic instability till they have lost much more blood, up to 50% more than non-pregnant patients (5). Such changes necessitate adaptations to trauma care methods, particularly in orthopedic trauma cases involving severe blood loss or surgical treatment. Given the added complications brought about by gestational physiology, worries about fetal radiation exposure, and perioperative monitoring standards, the management of pregnant patients with orthopedic injuries necessitates a customized strategy. The frequency, risk factors, and treatment of orthopedic injuries during pregnancy are the main topics of this study, which reviews English-language literature from 2011 to 2024. The databases Google Scholar, PubMed, ScienceDirect, as well as Scopus were used to find pertinent papers.

The most common mechanism of injury in pregnant women is blunt trauma. According to 2019 research done in Pakistan, falls were responsible for 31.3% of injuries, while motor vehicle accidents accounted for 47.9% (6). According to a 2016 study conducted in the UK, trauma from interpersonal violence and traffic accidents is becoming more common (7). In a similar vein, falls accounted for 28.1% of injuries in a 2012 Iranian survey, with motor vehicle accidents coming in second at 21.9% (8). According to reports, between 1% and 20% of pregnant women in the US experience interpersonal violence, with domestic partners accounting for the bulk of offenders (9). A number of risk factors for maternal trauma are also identified in the literature, such as lower socioeconomic position and younger mother age (<25 years), domestic abuse (11), inappropriate seatbelt usage (12), and insufficient or nonexistent prenatal care during the first trimester (13).

Younger women (those under 30) are twice as likely to encounter falls as older women, making falls the second most prevalent trauma mode during pregnancy (14). The forward change in the center of gravity brought on by lumbar lordosis throughout pregnancy, which results in instability, is one factor contributing to this elevated risk. Therefore, in order to reduce the risk of falls, excessive physical activity should be prevented in the later stages of pregnancy (15). Nearly 16% of pregnant women's injuries are caused by intentional or violent assault, and the third trimester is when intimate partner violence (IPV) peaks (16, 17). Regional and cultural differences in the prevalence and kinds of trauma emphasize the need for regional risk evaluation and response.

Pregnancy causes a number of physiological and anatomical changes that affect how the body responds to stress. For example, during the second trimester, blood pressure typically decreases by 5–10 mmHg (18), although heart rate may rise by 5–15 beats per minute (19). Due to plasma volume growth (20), hemoglobin concentration may drop by about 5 g/L, and the overall blood volume may rise to around 6 liters. These alterations make it more difficult to employ standard diagnostic indicators; for instance, high erythrocyte sedimentation rate (ESR) and leukocytosis are not trustworthy in pregnant women (21). Moreover, lymphocyte counts fluctuate during pregnancy, rising in the third trimester and falling in the first and second (22). Additionally, the rise in fibrinogen and clotting factors makes the body more coagulable, which raises the risk of thromboembolic strokes (23).

Pregnancy-related changes in physiology may potentially cause temporary osteoporosis, which increases the risk of fractures (24), particularly in weight-bearing bones (25, 26). Other difficulties arise from anatomical changes, including uterine enlargement. When pelvic fractures occur, an enlarged pelvic vasculature raises the possibility of a potentially fatal retroperitoneal bleeding. Furthermore, when the patient is supine, the gravid uterus can enlarge the inferior vena cava, which might result in a 30% reduction in cardiac output (4).

Assessment of trauma severity and quick stabilization are critical when pregnant trauma patients arrive at the emergency room. Fetal cardiac monitoring should begin before obstetrical consultation if the fetus is deemed healthy (≥ 23 weeks gestation) (15). The mechanism of damage, the mother's last menstrual period

(LMP), fetal movements, uterine action, and the existence of vaginal bleeding are all essential components of a focused clinical history. Along with the start of life-saving trauma measures, this first evaluation should be finished throughout the first minute of presentation. An appropriate substitute for continuous fetal surveillance is periodic Doppler evaluation or bedside ultrasonography for fetal heart rate measurement.

Orthopedic Injury Management and Diagnostic Issues for Pregnant Trauma Patients

Cross-matched blood transfusion is preferred over crystalloid solutions in pregnant trauma patients who continue to show hemodynamic instability in order to guarantee proper oxygen delivery and hemostasis (29). Unless the mother's life is in imminent danger, in which case this precaution may be postponed, type O Rh-negative blood is recommended in emergencies to prevent Rh alloimmunization (29). It is crucial to avoid supine hypotension in trauma patients who are pregnant, particularly after mid-gestation. While keeping the patient in a supine posture for trauma care, this can be accomplished via manual uterine displacement or left lateral positioning.

To identify internal bleeding in patients who are still hemodynamically unsteady, a Focused Assessment with Sonography for Trauma (FAST) should be included in the first assessment. This method's ability to detect retroperitoneal bleeding, which is more common in pregnant women because of increased uterine perfusion, is constrained, but (28). Additionally, ongoing cardiotocographic monitoring is advised for women who have a viable pregnancy after 23 weeks of gestation in order to evaluate the health of the fetus. An urgent cesarean birth may be necessary to maximize fetal outcomes in seriously wounded individuals who are older than 24 weeks and have unsettling fetal cardiac rhythms.

Laboratory Studies

Pregnant patients can be evaluated for trauma using the normal laboratory tests. Specific evaluations, such as blood type and assessment, coagulation characteristics, fibrinogen stages, and the Kleihauer-Betke (KB) test, are crucial in addition to the standard trauma panel. Given that as many as thirty percent of traumatic pregnancies result in fetal-maternal bleeding, this is very crucial. All Rh-negative trauma patients should get KB testing as early as 4 weeks of pregnancy in order to check for any alloimmunization hazards, per ACOG guidelines (4, 30). Increased white blood cell counts must be evaluated in combination with other clinical signs because of physiological leucocytosis during pregnancy. Furthermore, D-dimer testing has limited usefulness since it is not a reliable method of ruling out venous thromboembolism because levels are frequently raised during pregnancy (15).

Priority should be given to maternal stabilization and diagnosis; therefore, radiologic studies should not be postponed when necessary. When the mother's diagnostic advantage overcomes any possible fetal danger, even the use of gadolinium-based contrast agents is deemed permissible (15). Preventing the necessity for non-obstetric laparotomy is crucial since it has been linked to higher risks of premature labor, which can reach 82% in the third trimester and 26% in the second (31). If disorders that might endanger life or limbs are detected, diagnostic imaging should not be delayed because of worries about prenatal radiation exposure (4).

Ionizing radiation poses the greatest teratogenic risk during organogenesis, which occurs between weeks 5 and 10 of pregnancy. After this window, radiation exposure is less likely to cause structural abnormalities and more likely to impact embryonic growth or brain development (15). Notably, the fetus is much less vulnerable to radiation-induced developmental consequences beyond 15 weeks of gestation (32).

Ultimate Surgical Care

Fetal monitoring should start as soon as the mother's hemodynamics have stabilized. To lower perioperative risks for both the mother and the fetus, surgical operations should be as short as possible (35). Regardless of whether a woman is pregnant or not, she should receive emergency orthopedic care for life-threatening disorders, vascular-compromised injuries, and open fractures. In contrast, to prevent excessive fetal risk, elective procedures have to be postponed until after birth (1). Since pelvic fractures are

the primary incidence of trauma-related fetal death, they pose a serious risk to fetal viability (36). However, vaginal birth continues to be addressed in many third-trimester instances, therefore pelvic fractures alone do not need cesarean delivery (37). The possibility of significant bleeding, uterine damage, or placental abruption linked to such trauma is the main cause for worry (36). An emergency hysterectomy can be necessary to save the mother's life in situations when the uterine bleeding is uncontrolled (1).

A perimortem cesarean delivery should be considered when a pregnant trauma patient with a viable fetus does not respond to advanced resuscitation efforts or has injuries that are considered non-survivable. When all resuscitation attempts have failed, this surgery, which should preferably be carried out within five minutes after the mother's circulatory collapse, can offer the mother and fetus a chance to survive (4, 38).

Surgical and Perioperative Treatment of Orthopedic Trauma in Expectant Mothers

Because of the physical pressure on the gravid uterus and the easing of the lower esophageal sphincter brought on by progestin, pregnant individuals are more likely to aspirate when under anesthesia (39). The American Society of Anesthesiologists recommends elective surgery candidates refrain from solid meals for 6–8 hours and clear fluids for at least 2 hours before to induction of anesthesia in order to reduce this risk (40). The higher risk of premature labor must also be taken into consideration during perioperative treatment. During the perioperative period, the risk is considerably higher (41). Antenatal corticosteroid therapy should be taken into consideration to improve fetal lung maturity if an early birth seems likely, and the fetus is viable.

Mechanical prophylaxis, such as graded compression stockings or sequential pressure devices, is advised before inducing anesthesia due to the hypercoagulable condition that comes with pregnancy, especially for operations involving the lower extremities (43). Tetanus vaccination is safe to have during pregnancy and shouldn't be postponed. A 0.5 mL dose of tetanus toxoid should be given intramuscularly to individuals who have an entire vaccination history but have not received a booster in the previous five years. The toxoid and passive immunizations are necessary for those who have not received all recommended vaccinations (1, 44). The best possible patient placement is necessary to reduce the danger of aortocaval strain from the gravid uterus. To maintain venous return, the left lateral decubitus posture is advised whenever possible (42). Appropriate abdominal padding must be used to protect the uterus in situations such as posterior wall acetabular fractures, when prone posture is required (45). A wedge beneath the right side may be utilized to laterally move the uterus if full lateral placement is not possible, for example, because of an unstable spinal injury (1, 46).

The American College of Obstetricians and Gynecologists states that the kind of treatment, gestational age, and available assets should all be taken into consideration when making decisions about fetal monitoring during surgery (47). Fetal heart tone measurements taken periodically prior to and following surgery may be adequate throughout the first and initial second trimesters. Continuous intraoperative fetal monitoring, ideally by transabdominal ultrasonography, is usually necessary throughout later gestation, nevertheless. Transvaginal ultrasonography is a good substitute if abdominal access is restricted (42).

Techniques that reduce radiation exposure while maintaining correct alignment and stability should be given priority when fixing fractures in pregnant women (43). Despite being common in orthopedic surgery, minimally invasive techniques like intramedullary nailing and percutaneous plating can expose patients to significant amounts of radiation over time. Open plating techniques that need less fluoroscopic guidance could be better when this presents a serious risk to the baby (51). For stable, closed fractures of the extremities, non-operative therapy or therapeutic deferral till the following delivery may be appropriate (5).

There is a correlation between elevated mortality and morbidity of mothers and babies and pelvic and acetabular fractures during pregnancy (36). Hemorrhage management is the primary focus of prompt intervention when hemodynamic instability coexists with symphyseal disturbance. This includes volume resuscitation and the temporary stability of the pelvic ring. Experimental laparotomy with retroperitoneal filling as well as external fixation may be required if these steps prove unsatisfactory. Angiographic embolization could work better for arterial causes of bleeding (36).

Conservative treatments including popularity, including pelvic sling assistance, bed rest, and initial ambulation with help, could be adequate in less severe instances. In cases such as open pubic symphysis traumas with concurrent vaginal trauma, symphyseal diastasis larger than 4 cm, severe pelvic malalignment, diastasis that persists even after applying pelvic binder, or significant sacroiliac joint displacement, surgical correction is recommended. Procedures such as percutaneous fixation or open reduction with internal fixation (ORIF) should preferably be carried out within three weeks of the injury when surgery is necessary. This time permits fetal development to continue until at least 34 weeks of gestation while also protecting the uterine environment. Patients can attain upright placement by techniques such as supra-acetabular fixation, which enhances breastfeeding and mobility (5).

Surgical Decision-Making and Results in Patients with Acetabular and Pelvic Fractures During Pregnancy

The orthopedic literature has long recognized the advantages of surgical care for acetabular fractures, with results being considerably better when surgery is performed within three weeks after the injury. Reliance on revision operations or delays past this window is likely to decrease the chances of the best possible functional recovery. Open reduction and internal fixation (ORIF) have emerged as a feasible and often chosen treatment option for acetabular fractures in pregnant women due to new evidence demonstrating the safety of fluoroscopic imaging, anesthetic, and surgical fixation during pregnancy (44).

However, vaginal birth is not always prohibited by the existence of a pelvic fracture. A safe vaginal delivery is possible if the pelvic structure is mostly intact, and the fracture has healed properly. Since it usually takes 8 to 12 weeks for bones to heal, pelvic fractures that occur early in pregnancy frequently give enough time for recuperation before birth. Assessing for pelvic malunion or incorrectly positioned implants is crucial when considering delivery choices. Considering the safety of both the mother and the fetus, vaginal birth may be tried if they are not present and the pelvic anatomical structure is maintained (1,43,45).

Trauma patients who are pregnant are disproportionately more likely to experience morbidity and death. They are twice as likely to die after trauma as their non-pregnant counterparts, and violent injuries play a significant role in this figure. Violence-related trauma is especially lethal, with death rates in this demographic more than three times greater than those of non-violent trauma (11). Less than 1% of instances include direct fetal damage brought on by maternal trauma. The uterine wall, maternal soft tissues, and amniotic fluid all offer significant protection from outside influences. The late third trimester, when the uterine wall is thinner and the amount of amniotic fluid has dropped, does, nevertheless, tend to see a rise in fetal injuries. Placental abruption, which occurs in five percent to fifty percent of trauma instances and is the primary cause of fetal death after blunt-force damage, is one of the most serious side effects of traumatic abdominal trauma. Abruption placentae is the most important predictor of fetal death in severe situations, occurring in 60% of cases and second only to maternal death (15, 45).

Despite the unpredictability of many traumatic occurrences, evidence strongly favors the adoption of preventative measures, particularly seat belts. Seat belt usage during pregnancy dramatically lowers maternal and fetal difficulties in motor vehicle incidents, according to several studies. Pregnant women who do not use seat belts during crashes have been linked to a 2.8-fold rise in fetal death, a two-fold rise in maternal bleeding, and a 1.3-fold rise in premature deliveries (46). Unfavorable fetal outcomes were observed in the entirety of high-impact collisions in a different cohort in which the pregnant mother was not using a seat belt (28). Appropriate seat belt installation is also essential; improper belt placement has been implicated in almost half of all fetal deaths in these incidents (30). Airbags' contribution to pregnancy-related trauma is still up for debate. It is more probable that the intensity of the collision, instead of the airbag itself, is responsible for these results, even if certain cases have linked airbag deployment to major obstetric problems, such as uterine rupture, premature delivery, and baby loss. There is currently insufficient evidence to draw firm conclusions about whether pregnant car occupants should have their airbags disengaged (15).

Conclusions

The treatment of fractures during pregnancy is a difficult task that requires a thorough grasp of both maternal and fetal physiology. Pregnancy-related changes in biomechanics, vascular volume, and hormones raise special issues for musculoskeletal trauma diagnosis, management, and recovery. Timely and accurate diagnosis while reducing prenatal exposure to ionizing radiation is one of the most important components of treatment. Imaging options such as MRI and ultrasound should be used whenever possible. Abdominal shielding and dosage reduction techniques should be rigorously followed when X-rays or CT scans are necessary. Early diagnosis is crucial to avoid delays that might endanger the health of the mother and the fetus.

Although occasionally inevitable, surgical treatment needs to be handled carefully. Because of the decreased risks of teratogenicity and premature labor, the second trimester is typically thought to be the safest time for elective surgery. Because anesthetic drugs, surgical placement, and perioperative medicines all affect the physiology of both the mother and the fetus, multidisciplinary planning is essential. Because it reduces systemic exposure and permits intraoperative fetal monitoring, regional anesthesia is preferred. Thromboprophylaxis, pain management, early mobility, and attentive mother and fetal monitoring are all part of postoperative treatment. Especially close to birth, anticoagulation decisions must strike a balance between safety and effectiveness. Because serious injuries during pregnancy can be emotionally upsetting, psychological assistance is also crucial.

In conclusion, the effective therapy of fractures during pregnancy depends on a well-coordinated, multidisciplinary team that includes orthopedic surgeons, obstetricians, anesthesiologists, radiologists, and neonatologists. The probability of positive results is greatly increased by personalized care that is guided by current best practices and cooperative planning. Clinicians may handle these difficult clinical situations with more assurance and skill if they prioritize fetal preservation and maternal stability at the same time.

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استراتيجية شاملة متعددة التخصصات لإدارة الكسور العظمية الهيكلية أثناء الحمل: التقييم، العلاج، والاعتبارات المتعلقة بالأم والجنين

الملخص

الخلفية: تُشكل الكسور المرتبطة بالحمل تحديات خاصة بسبب التغيرات الفسيولوجية والتشريحية والدوائية التي تؤثر على استراتيجيات التشخيص والعلاج. ويتطلب ضمان سلامة الأم والجنين العمل التعاوني بين مختلف التخصصات الطبية.

الهدف: تهدف هذه المراجعة إلى استكشاف الفهم الحالي والممارسات الموصى بها لعلاج الكسور أثناء الحمل من منظور متعدد التخصصات، مع التركيز على سلامة التشخيص، خيارات العلاج، والنتائج المتعلقة بالأم والجنين.

الطرق: تم إجراء تقييم سردي للأدبيات المتوفرة شمل تقارير الحالات، والإرشادات السريرية، والمراجعات ذات الصلة. وقد تناول التحليل عملية اتخاذ القرار الجراحي، ورعاية ما بعد الولادة، والاعتبارات المتعلقة بالتخدير، وأساليب التصوير التشخيصي في سياق الحمل.

النتائج: تشمل التغيرات الفسيولوجية المصاحبة للحمل والتي تؤثر على علاج الإصابات: زيادة حجم الدم، وارتخاء الأربطة، وتغيرات في استقلاب الأدوية. تُعتبر تقنيات التصوير التشخيصي مثل التصوير بالرنين المغناطيسي والموجات فوق الصوتية آمنة نسبياً، لكنها قد تنطوي على بعض المخاطر للجنين. عند الحاجة للجراحة، يجب أخذ عمر الحمل بعين الاعتبار؛ إذ يُفضل إجراء الجراحات غير الطارئة خلال الثلث الثاني من الحمل. يُعد التعاون بين فريق متعدد التخصصات يشمل أطباء حديثي الولادة، وأطباء التوليد، وجراحي العظام، وأطباء التخدير ضرورياً لتحقيق أفضل النتائج. ويفضل استخدام التخدير الناحي عند الإمكان بدلاً من التخدير العام. تشمل رعاية ما بعد الجراحة مراقبة الجنين والوقاية من الجلطات.

الاستنتاج: تتطلب إدارة الكسور لدى النساء الحوامل نهجاً منسقاً ومتعدد التخصصات لتحقيق التوازن بين احتياجات الأم وسلامة الجنين. يُعد التخطيط المبكر، وتقييم المخاطر، وتخصيص العلاج من العوامل الأساسية لتقليل المضاعفات وضمان نتائج إيجابية لكل من الأم والطفل.

الكلمات المفتاحية: تخدير التوليد، الإصابات، العلاج متعدد التخصصات، صحة الأم والجنين، كسور الحمل.