Presenters: Stephen Lu, MD, FACS and Salim Amrani, MD

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COURSE OBJECTIVES

* Identify dangers posed by trauma to pregnant patients.
* Recognize steps for initial evaluation and resuscitation of a pregnant patient.
* Indicate elements of colon/rectal injury resulting from penetrating trauma.

TRAUMA IN PREGNANCY

Speaker: Stephen Lu, MD, FACS

I’m Steve Lu. I’m a general surgeon and I’m the director of the trauma program over at UNM (University of New Mexico) and I’d like to thank everyone, Dr. Amrani and Chris Armendariz for having me and thanks to all of you for showing up. Hopefully, we’ll make it worth your while. I’m going to be talking about trauma in pregnancies, so this is one of those topics that always induces a lot more stress than you think it should when people show up. Typically, like last week I was on call. We had a 24-year-old woman, restrained motor vehicle crash. She said she was about 24 weeks pregnant and came in pretty stable and so the question is, “Okay, how to proceed from there?” So, we’re going to talk about what the issues are in terms of potential pregnancy; what are the anatomic and physiologic changes that are involved when you have a pregnant patient; and then, of course, the main source of people’s distress which is that it’s one of the circumstances where we have two patients in one and so it’s, “How are we going to balance off the different priorities of treating the mother and the fetus?”

The key thing to remember is that, fortunately, within the framework that we try and teach for trauma assessment in general that the initial priorities are always going to be the same. So, regardless of whether the patient is pregnant, pediatric, Republican, Democrat, Tea Partier... the priorities are the same. So, it’s always going to be airway, breathing, circulation, disability and we’re going to kind of work within that framework and then talk about surgical management and the role of obstetric consultation.

Alright, trauma is the leading cause of maternal mortality in pregnancy. About 7% of pregnancies are complicated by injuries. Fortunately, severe injuries requiring operations or ICU management are relatively rare. Most of these are motor vehicle collisions; however, there is a significant amount of falls, physical abuse, and then about 10-20% of penetrating injuries.
In terms of when you get a patient that has a traumatic injury in pregnancy, one thing that you always have to be really aware of is the very, very high incidence of associated abuse in these presentations. Depending on the study you read, it could be anywhere from 1-in-5 pregnancies could be complicated by either sexual abuse or domestic violence and physical trauma and these are associated with a significant number of mortality -- so about 3% of maternal mortality and a very high fetal mortality rate, so about 16-20%.

Alright, I think that the thing that strikes most people is the physical changes of pregnancy. When you look at somebody that’s pregnant it’s like, from early pregnancy it may not be very apparent to later pregnancy when it actually starts making the physical management of the patient more complicated. Some of the main landmarks that you’ll sort of see on the surface anatomy are up until about 12 weeks; the uterus is still an intra-pelvic organ and then the uterus progressively grows until about 20 weeks; it’s about the level of the umbilicus and then at 36 weeks it should be about at the costal margin. So, if you have a presentation where the uterus is not corresponding to the level that you would expect from their gestational age, then you have to worry about a possible uterine injury.

Along with the anatomic changes come a series of physiologic changes. In the first trimester, again the uterus is relatively small and within the pelvis, so it’s relatively protected. Also, it’s thick-walled and so the fetus is protected from direct injury. So, most of the risks are spontaneous abortion -- loss of the fetus -- and then isoimmunization which is where there is bleeding of the fetal circulation into the maternal circulation so you can get immunization against the fetal blood.

In the second trimester, then the uterus starts coming out of the pelvis and then you start having a significant amount of amniotic fluid around the fetus itself which cushions the fetus, but you have now the significant risk of amniotic fluid embolism. In a patient that’s second trimester or further, if they have sudden cardiovascular collapse, then you have to suspect possible amniotic fluid embolism. Also, at this stage the placenta can abrupt and, unfortunately, there are not a lot of really good diagnostic tests for that. We’ll talk about that a in a little bit and then again, the risk for isoimmunization. Then finally, in the third trimester the uterus is most prominent and that’s where you have displacement of the abdominal viscera. Actually, at this point the fetus becomes much more vulnerable and the mom actually is relatively more protected, so hollow visceral injury becomes much rarer actually at this point in pregnancy. In traumatic injuries to the abdomen, it’s much more likely that the fetus will be injured and not the mother. Also, the solid organs are displaced further up under the rib cage so they’re more protected.

The main hemodynamic thing you have to look out for is the uterus is so prominent that it can start pushing against the cava itself and what happens is then the blood can’t return back to the heart. So, if you lay a pregnant woman straight back on their back, then they can actually have a significant drop in their blood pressure because the blood can’t return to their heart. So, you have to roll them to their left side to displace the uterus off the cava.

The risks that you see in the third trimester then become much more like direct injury to the fetus, especially with pelvic fractures and late in the pregnancy the head will engage into the pelvis and
so you can get fetal brain injury from pelvic fractures and then again, the risk of abruptio placenta, amniotic fluid embolism, and isoimmunization.

Alright, so the global physiologic changes that go along with pregnancy are, you know, in preparation to support the baby, basically the mother is breathing for two, so they have to clear the carbon dioxide, so you’ll get a hyperventilation and you’ll see a decrease in the maternal CO2; the blood volume of the mother increases; the actual amount of red cells that a pregnant woman has actually goes up also but it doesn’t go up as much as their blood volume does, so their crit will look artificially low. And then again, because they have to support the circulation of the fetus then their heart rate and cardiac output will proportionately increase. The upshot of all that is that actually because there is more maternal volume, they can have a lot more bleeding and not show signs of a low blood pressure or high heart rate, so you have to watch out because shock may not manifest itself as early.

Also, their kidneys have to work harder because they’re filtering for two patients. As the fetus grows, it pushes up against the stomach, so the stomach doesn’t empty as well and the stomach is smaller so the risk of aspiration becomes much higher. In the pre-hospital setting that’s particularly important. Then you’ll also see a leukocytosis, usually like in the teens; it can go up into the 20’s during delivery.

Again, the basic framework is still the same -- it’s airway, breathing, circulation, disabilities. The things that are slightly different in patients who are pregnant are that because they have decreased gastric emptying, they are at a higher aspiration risk. If you can, you want reverse Trendelenburg, keeping their head up if possible. It’s going to be more difficult for them to ventilate, basically all that stuff is pushing up against their lungs, so it’s harder for the diaphragm to move. And then because they have this extra blood volume, it’s easy to not recognize blood loss. Then for disability, when you’re assessing the neuro status, you have to just be aware of the possibility that altered mental status might be from eclampsia and not just from brain injury.

The thing that you can always count on is if you’re monitoring the fetus is that with maternal blood loss, fetal distress will precede change in the mom’s vital signs. Basically, the placental circulation is very sensitive to Catecholamines. Basically, the mother will try and preserve maternal circulation at the expense of the fetal circulation. One of the most sensitive indicators that there is ongoing blood loss is that the fetus will start showing more signs of distress in their heart rate tracing. So, it’s very much a kind of “canary in a coalmine” type of phenomenon.

Alright, so in the pre-hospital setting the main thing, again, is just support of the mother. Supporting the mother is always the best thing for the fetus. Again, airway breathing, so a lot of oxygen; make sure that there’s liberal use of IV fluids to support circulation; if you can, in late pregnancy you’re going to tilt the backboard to the left, again, to get the uterus off the cava; and then you want to, as early as possible, inform the receiving institution so that they can have OB ready, if possible. And then if delivery appears imminent then remove clothing to allow possible delivery.

You’re managing the two patients -- the mother and the fetus. Again, the first things are always the primary survey and resuscitation of the mother because the maternal circulation will always be
preserved relative to the fetus, and then fetal assessment. Then the secondary survey of the mother, so that’s going to be your history and your top to bottom to make sure you didn’t miss injuries, and then we’ll talk about definitive care. So, basically for Rh-negative moms, if you know that then they should get RhoGAM to prevent isoimmunization except for minor, extremity-type injuries but basically all torso traumas, and then early OB consultation.

Alright, so again, initial treatment priority is the same -- you’re going to do oxygen, fluid resuscitation, avoidance of hypotension. So, if you have to do therapeutic maneuvers, the things you have to look out for are again, the uterus is displacing all your viscera upwards, so basically all your interventions you’re going to sort of move all your landmarks up. So, if you have to put in chest tubes, they should put them 1-2 inner spaces higher than you normally would; and then fortunately ultrasound has mostly replaced diagnosis peritoneal lavage but if we’re going to do that then usually you’re going to do that supraumbilical instead of infraumbilical. When you give blood products, they should be Rh-negative and then again, for neuro assessment you always have to consider the possibility of eclampsia.

Once you’ve established initial stability, you’re going to go onto your secondary survey, identify maternal injuries and establish the viability of the pregnancy. So, you’re going to try and find out basically is the fetus above the level of viability. What’s the general cut off for what’s accepted as a viable fetus? It used to be 27 then it went to 26. I think that everyone would agree that at this point probably at least 24 and then NICU people are sort of pushing that all the time but I think that most people would say that definitely by 24 weeks would be considered a viable fetus.

Any diagnostic radiographs that you need should be obtained. So, DPL (diagnostic peritoneal lavage), abdominal CT, abdominal ultrasonography can all be used. We’ll talk a little bit more about the use of diagnostic imaging here. This is always something that creates a lot of angst between physicians and radiologic techs and the ER because everyone is trying to balance off the different priorities. So, from a trauma surgical standpoint we’re always like, “We are saving the mom first, and if there is a high risk of significant mechanism or any instability we’re going to get a CAT scan or we’re going to go to the OR because saving the mother is the best way to save the fetus.” However, a lot of cases are not so clear-cut because then you have all these patients that come in and they’re in a fender bender or they were T-boned but they were restrained and they’re stable, they have a little bit of abdominal pain and then it’s, “Okay, now we have a stable patient; how are you going to make that decision and who is going to inform the patient about the risks?” So, at UNM to get a CT in a stable pregnant patient we actually have to consent them and consent is done usually someone in radiology but sometimes it can be the ED physician. Each institution is going to have to come up with their own protocol in terms of how they balance that out.

The general principle is going to be that you’re going to try and minimize ionizing radiation if you have alternate modalities that provide similar information. Sometimes that will just be clinical exam. So, the patient looks fine; they don’t have any obvious signs of distress; they don’t have abdominal pain or tenderness; they don’t have contractions; and you may just say, “Okay we can do serial exams and monitor them” and that will be great. Most of the time you’re going to get ultrasounds and then MRI is becoming more widely-used but it hasn’t really been validated a lot so there are not really standards
around that. Again, if it’s a major mechanism we’re going to get a CT. What can you do in those cases where you have to get imaging studies? If you can, shield the fetus and actually for a lot of our plain films we can do that. Then just to give you a perspective on the amount of radiation that is going to get delivered, a chest X-ray, plain films -- very, very little radiation -- 0.002 rad; a pelvic X-ray 0.06 rad. We’ll talk about the thresholds that people worry about but they are way below that. So, you could get hundreds of chest X-rays and not get into any sort of range where we’d worry about the radiation exposure, but you can see that once you get to CT of the abdomen and pelvis, it can be anywhere from 1.5 to 5.0 rads and once you start getting into serial exams that really becomes an issue. It’s really when we’re talking about CT’s especially to the pelvis that the overall issue of exposure becomes more significant.

What are the risks with radiation? There is immediately loss of viability including non-implantation of the fetus and it is greatest within two weeks of conception. So, usually, when we will not be aware that they’re pregnant actually, within this period and we’re talking about really high doses. It’s thought that it would take a dose of greater than 50 rads to have immediate loss of viability; so not a likely outcome but, again, most of these will not ever be clinically-apparent.

One that definitely people worry about is this risk of radiation-induced malformation and this is one that’s probably more... probably the best studied of all of them. It’s clear that risks of organ malformation occur during the organogenesis period -- 2-7 weeks and that it’s felt the risk increases above 5 rads or so. Again, one initial exam is probably not going to put you in that range but you can see how once you get to repeated exams that it starts becoming a problem; and then growth retardation above about 50 rads. Then for cancer risk, there’s very little data in pregnant women at all and the best data that we have comes from the National Health Service in Great Britain where they basically looked at all the CT’s they did in kids over a ten-year period and once you start getting about 3-5 studies, then you start having doubling, significant increases in the overall risk of cancers. Now, there’s not actually a threshold, so basically it looks like any sort of study increases it slightly; however the baseline incidence of cancers in kids is so low that even increasing their risk still puts them at a very, very low risk overall. Again, there’s not a whole lot of data. The CDC states the risk as “may increase to 1-6% when the cumulative exposure is greater than 50 rads”, so again, you’d be talking anywhere from like 20-50 CT scans for that to happen.

Now, we’ll move on from radiation to other complications such as isoimmunization. Basically, the American College of OB/GYN has recommended RhoGAM for all Rh-negative patients that have abdominal traumas. So, if they have an extremity you don’t have to worry about it. There’s not really a whole lot of role for the Kleihauer-Betke other than to... if it’s really, really positive you might give more RhoGAM.

Moving on from the mother to evaluation of the fetus, again, fetal evaluation will always be secondary right, because if you don’t keep the mom alive then it’s very, very unlikely that you’ll have a fetal survival. Again, you’re going to exam the uterus for size, tenderness, and contractions, pelvic exams should probably be done by OB unless you have the ability to deliver a child right away; and then mainly it’s going to be ultrasound and evaluation of fetal heart tones.
The things that are going to be more warning signs for fetal injury are vaginal bleeding; if you can see an abruption on ultrasound; and then on physical exam it’s really going to be uterine tenderness. Signs of uterine rupture are sort of an abnormal fetal lie; again fundal height that’s less than what you’d expect; or the patient is going into active labor.

Alright, so ultrasound, one of the best things in terms of your initial evaluation of how the fetus is doing... just mainly a lot is going to be just the fetal heart rate by itself and then appropriate positioning of the fetus within the uterus. Ultrasound is only about 50% sensitive for abruption, though, so just because you have a negative fetal ultrasound does not mean that the patient is not abrupting and that’s why we still have the requirements for monitoring.

In terms of the FAST (Focused Assessment with Sonography for Trauma) exam that we use specifically for trauma (that’s the four-view quick ultrasound assessment of the abdomen) it seems like it’s got results very similar to non-pregnant patients. This study is from 2001 and they did mostly second and third trimester patients. It has a pretty reasonable sensitivity and specificity. Again, this is going to be for unstable bleeding in the abdomen, so it’s a very, very specific thing that they’re looking for but in those circumstances where you have an unstable patient, pregnant, you’re worried about intra-peritoneal bleeding, the FAST exam will give you a pretty good indication of that. And then for your stable patients then who do you have to admit for monitoring.

We’re going to toot our own horn a little bit here so this is Dr. Kuret and Dr. Shermer, were at UNM back in the early 2000’s. They did this huge chart review of 271 pregnant patients and basically the main risk factors for pre-term labor were gestational age of 35 weeks; assaults; pedestrian collisions; and then the main ones for fetal death are the higher energy mechanisms such as motorcycle accidents; again, pedestrian struck; and then if the mother starts showing signs of physiologic stress, so the elevated heart rate; they have a higher injury severity; obviously, if the mother dies then the fetus almost always dies; and then the placental abruption and the abnormal fetal heart rate. So, that’s become the standard in terms of who should be monitored. Basically, if you have any of those major mechanisms with either pre-term labor; if there’s fetal loss then the mother needs to be monitored for 24 hours. Without those risk factors, it’s going to be whether the 6-hour window is necessary is controversial; some institutions have brought it down even to 4 hours.

In general, once you identify injuries then the management is going to be basically the same whether they are pregnant or non-pregnant. For specific indications for a C-section, basically uterine injury; shock in the mom in near-term pregnancy; so it’s thought that by delivering the baby, it will allow for more vasoconstriction and preservation of the maternal volume. Severe coagulation problems, again that’s from amniotic fluid embolism and then having injuries that you can't get to because the uterus is present and then fetal distress itself during an operation.

One thing that is often talked about even though almost never happens -- in my entire almost 20 years in medicine now I’ve seen this happen once and that is Caesarean section for trauma, after maternal death. So, basically, this is the study that constantly gets cited just because there’s not a whole lot of data. They looked at 441 pregnant patients, 32 emergency C-sections and, basically, if you
didn’t have fetal heart tones on presentation then survival is nonexistent. If you have fetal heart tones present in a patient that was greater than 26 weeks then they actually had a pretty good survival. It’s a pretty straightforward decision in terms of your evaluation. It’s like, you know, the mom comes in, alive or not, evaluate for fetal heart tones. If there are fetal heart tones, section them.

So, in conclusion, the anatomic and physiologic changes of pregnancy influences the evaluation and treatment of the injured pregnant patient; however, the main thing to remember is, your fundamental priorities are going to stay the same. Aggressively prevent and correct maternal and fetal hypoxemia and again, the best treatment for the fetus is always treatment of the mother; and then obtain surgical and obstetric consultation early in the evaluation of your pregnant trauma patients and, hopefully, you will have lots of good outcomes.

Thank you very much and I’d be glad to take any questions.

Colon and Rectal Trauma

Speaker: Salim Amrani, MD

Okay, so we’re going to be starting with our second talk and I’ll be presenting this; not very common but very important the “Colon and Rectal Trauma.” Nobody likes to present this kind of stuff but someone has to do it. I’m by training a colorectal surgeon and by mission a trauma director here, so I kind of picked up this subject because I feel more comfortable with that, I guess.

Anyway, we cannot talk about colorectal trauma without some historical perspective. For centuries, as far as the human was known there was really not much to be done for these kinds of injuries and they were basically untreatable. If you had an injury, you get some kind of sword getting into your belly and you get an injury, you are basically dead. So, Hippocrates came in with this view that he regarded all of these abdominal wounds usually to be deadly. If you had a penetrating injury to the abdomen, you are basically dead so we are kind of glad in this day and age not to have to deal with that.

Celsus, who was a Roman doctor who wrote encyclopedias, advised that the cure be left to nature. (I love how philosophical they were back then). However, the first successful repair for an injury was described by a French surgeon, Lucien Baudens, who was one of the surgeons of the French army during the conquest of Algeria. One of the soldiers got shot with the musket bullet and when he presented to him, that patient obviously was stable, so he examined him and found this wound in his belly. He kind of put his finger inside the wound... Obviously, there was no anesthesia then, so imagine... And when he pulled out his hand out of the belly he saw stool over his finger. At that point he kind of stretched the wound a little bit, made it a little bit bigger, and asked the patient to cough. At that point, the patient expelled a huge amount of air and the injured segment of the colon came out of the wound. At that point he repaired it with what we call lambert sutures which is just what we do as closing the wall of the colon with the regular suturing -- there were no staples then for people in the OR. And once he finished, he put that piece of intestine back in and the patient survived. So, this was the first time ever someone survived from this type of injury and it’s been reported.
After that, we had the Civil War and these penetrating injuries were deadly at a rate of 90%. Again, they were treated non-operatively as Celsus would say, “Just leave them alone and see what happens” and then we noticed that 90% of people will die and they didn’t do that because they didn’t want to do anything but at that time, regardless of what they did, the patient would have died so they kind of left the selection to nature.

The World War I saw some improvement. At this point, surgeons started understanding the anatomy better and the peritoneal cavity and the danger of getting into the abdomen was less than years ago. So, people started to do some surgery, anesthesia was starting; people were understanding more about asepsis and techniques of keeping things clean, but the standard at that time was just, “Hey, if you find a wound, you repair it, and see what happens.” There was some improvement, if you look at between the mortality from the American Civil War and First World War; there is an improvement which is from 90% to 60% mortality which is a huge improvement at that time.

Then came World War II and this saw an increase of very deadly weapons -- we’re talking about rifle guns and shots and bombs and at that time the primary repair resulted in increased rate of mortality. Actually, it was probably worse than the First World War. So, there was this major general whose name is Ogilvie who was much less known for that but very well-known for the Ogilvie Syndrome that most of the surgeons are aware of. And he was appointed by the British army (I think he was Argentinean or Chilean, I’m not sure but anyway), he was appointed by the British army due to his knowledge and he was part of the military expedition over North Africa and he came up with the concept that every injury to the colon will require colostomy or actually exteriorize the colon. Back then what they did, if you had an injury into your colon the surgeon will go in and find that injury and just pull it out outside the abdomen and leave it to heal outside, whether by forming a colostomy or kind of suturing and leaving it out there.

Seeing a major improvement in that, so the Americans at that time said, “Well, we’re going to follow the British strategy and we’re going to do the same thing.” So, the American forces adopted the same policy and this reduced the mortality down to 35% from these colonic injuries.

Then came the Korean War and Vietnam War and it’s interesting that we learn a lot of trauma based on the war and that’s how most of the trauma evolved because we see such horrific injuries and the civilians learned from that. In the Vietnam era, the mortality dropped down to 15% and down to 10%. Why? Because now we have more potent antibiotics; better understanding of different diseases; better evacuation system with the helicopters; and availability of blood products. So, after the World War II, all these surgeons that were mobilized in the military ended up applying all the concepts learned in the civilian population.

Today, the mortality is way below what was known by Hippocrates and it’s down to 5% or less, especially in advanced trauma centers. There was a great paper in 1979 by Stone and Fabian and this paper was kind of very audacious at that time where they said, “Well, we don’t have a good answer; in certain times people were just closing these wounds; at certain times people were just bringing them out and letting the patient poop outside; and said, well, let’s see what happens if we repair or we
perform a colostomy to these patients. So, they selected what they called “patients with colonic injuries that were good risk patients.” Obviously, they didn’t pick up the ones with the severe shock or the one with severe extreme of age. So, they picked up a good population and said, “Well, we’re going to treat half of them with primary repair (which was kind of just close the colon with stitches and put it back in the abdomen and close) and we’re going to take all the people and just bring the colostomy out and see what happens.”

Well, there were actually fewer septic complications from the people that had the primary repair and the closure of the abdomen and this was kind of a seminal paper. What is the mechanism of the trauma for the colon? Obviously, two types of mechanism -- see the penetrating or blunt trauma. The penetrating trauma is the one that causes the most colonic injuries. If you have people involved in a car accident, they are less likely to have a traumatic injury to the colon; but if they get shot or get stabbed, this can account for 20% of the injuries they can have will be a large bowel injury. The most tissue injury usually occurs from the gunshot wounds because, as you know, the gunshot wound can travel from one side to another of the belly; it can cause an important amount of energy damage and burn inside the tissue.

So, how do we deal with a stab wound? Let’s say a patient comes in and he’s been stabbed and he made it to the hospital, and this patient is totally stable. You see a wound in the abdomen; it’s less than an inch, how do you manage that? Obviously you still go by the ABC’s of trauma. You don’t jump to any conclusion; you check the patient’s airway, breathing, circulation; get his blood pressure, his vitals, check his disability. Following that, you’re going to be examining that wound. Is this patient someone who needs to get to the OR or is there an alternative? Obviously, before the era of CAT scans and ultrasounds and things like that, 99% of these patients went to the OR. However, we found out that by doing that a lot of patients would end up having negative laparotomies, meaning you go inside, you look around, and there is no injury and the patient stays in your hospital for 5-7 days with severe pain and really you didn’t achieve much. But on the other hand, you saved the 20% that really had an injury.

There is a paper from the Journal of Trauma in 2010 that set up some parameters about how to handle these patients. Obviously, anybody who is non-stable will obviously need to go immediately to the operating room -- that’s not a question. But for the stable patient, you should really delay that decision until you make sure the patient has an injury or not. The way you can do that is very simple. If the patient is stable and he’s not expressing so much distress and abdominal pain, you can fairly observe him; admit him to the hospital for 24 hours; and see what happens. If he’s not getting worse, likely he’s not going to get worse; however, if the patient develops any sign of sepsis, fever, severe abdominal pain, now you have him under your hand and it’s time to take him to the operating room.

The CT scan really helps. It’s an adjunct. Really, it’s a good exam to tell if there is an amount of fluid in the belly, free air, but it won’t be able to tell you for sure if there is an injury to bowel -- specifically small bowel, but it can give you an indication especially in the case of a deeper penetration of the knife inside the patient’s belly. The people, as I said, that are going to be managed non-operatively can be safely discharged after 24 hours without many consequences.
Now, there is a concept of laparoscopy. You can observe the patient. You can say, “Hey, I’m not sure how deep your wound is; I can do an exam inside, in the ER; see if it passed the fascia or not, I’m not sure. The other way I can tell is by taking you to the OR and put a camera inside your belly and see what I can see. Actually, we had a patient like that where he came in; he was completely stable; and I wasn’t sure about how deep this is. We took him to the OR; he was having a little bit more pain; and sure enough we’re looking from the other side of the belly, from the area where we suspected the injury, and we see that actually this penetrated the abdominal cavity. The patient was in pain so it was time to explore him. We explored him; didn’t find any injury; but at least he deserved that exploration.

The CT scan and the FAST, again, as I said are adjuncts and will not give you much information for a hollow viscus injury except that if you find free air, then this is obvious. The FAST is most useful in blunt trauma.

In any case, the blunt trauma patients comprise less than 5% of the cases of colonic injuries and this is explained due to the fact that before getting to these injuries, you’ll probably have a spleen injury or a liver injury or any kind of other organ and to cause such a shock to the colon by a blunt trauma, you have to have a massive amount of energy. What are the places where you find most of the injuries? They are usually the cecum, transverse colon, and sigmoid colon. Why is that? It’s because these are the non-fixed areas of the colon. If you’re familiar with the colon anatomy, the cecum is kind of floating in the abdomen as opposed to the right colon which is attached to the side. Same thing for the transverse colon... it can be very mobile, moving up and down; and same thing for the sigmoid colon, it can be easily mobilized. But most of the perforations are in the sigmoid colon -- mainly from motor vehicle crash and deceleration injuries.

Why is that? You have a patient that’s strapped mainly by his seatbelt and then suddenly he goes from 120 miles an hour to zero. You can imagine all the force where these non-attached parts of your colon kind of get really pushed forward and can stretch and cause mesenteric injury and even tear into the colon wall. As I said, use of seatbelts seems to be a risk factor. If you see a patient in the emergency room with a huge bruise into his abdomen you have to be very suspicious about colonic injury or small bowel injury. And also if you do a CAT scan and you find lumbar injuries then your suspicion goes high, especially if you see free fluid in the pelvis without major organ injury. Let’s say your spleen is intact; your liver is intact; but you see a good amount of fluid and you have vertebral injury, this is a high indication the patient probably has some bowel injury that’s not declaring itself right now.

The peritoneal lavage again, like Dr. Lu said, is kind of a thing of the past, but let’s say if you don’t have any other means and you do that, it’s only valuable if you find frank stool coming out of there. Seeing blood nowadays might not be very helpful unless it’s a huge amount. The FAST also will detect colonic injury only if there is a huge amount of fluid without evidence of solid organ injury.

What’s good about the CT as an adjunct, if you’re kind of not sure what to do with this patient, you do a CT, and it gives you more information about the complication that you’ll be facing if you had to go to the OR or the mechanism or what happened inside the belly. You kind of have an idea before
you’re in there. But the problem with the CT is you may completely miss a mesenteric injury. You can look at it and the CT can look completely normal and yet you have a piece of colon or small bowel that can completely devascularize and you may want to observe the patient and the patient may worsen over time. If you see hematoma of the mesentery, edema, bowel wall thickening, presence of fluid, again, without evidence of solid organ injury, this is an indication something is wrong with either the small bowel or colon.

How do you manage these lesions? We already alluded to the repair -- primary repair or performing colonoscopy. We have a good way, now, to do these things and again this has evolved over time. One other principle... if we’re going to go and do an exploratory laparotomy for that, you want to have a midline incision; you want to avoid cutting through the muscle. If you have to do a colostomy, that’s where your colostomy is going to come through, through the rectus muscle, so you want to preserve this area. The first thing you want to do, like any trauma, you want to control the source of bleeding. You’re not going to jump into fixing the colon. Now, if you have a liver laceration that’s bleeding or a spleen that’s bleeding, you address that first. You pack the patient; you stabilize that area; and then you deal with the colonic perforation later. Once you get, that the second step you do is controlling the source of contamination. As we know, the colon has stools in it and the more contamination happens, the more the patient is going to suffer down the road. So, as soon as you can, you start putting clamps around the injury to kind of limit the contamination. You can put packing to protect other areas of the belly.

So, the next thing you do is counting the number and the locations of your injury. Let’s say someone gets shot with one bullet and then you see three wounds, you are pretty sure you missed one and you have to look very carefully, especially in the area of the mesentery which is the attachment of fat to the bowel and that area can be damaged without you being able to look at it, so you have to be very careful. So, usually an even number is better. You look for the missing hole; if you don’t find anything else then you proceed with the primary repair.

How you do your primary repair? It’s stitch... you can do it in one layer or two layers, depending on what you feel comfortable with and there is really actually no difference and you repair it in a transverse fashion. What you want to avoid is a complication later from stricture. If you repair it in a horizontal fashion, it’s likely that you’re going to have a stricture and patient having bowel obstruction or difficulty having his gastric content moved past that point.

If you have a blood supply issue and compromised mesentery, then you have to re-sect that segment. It’s as simple as that. If your bowel doesn’t look right, you take it out. Now, if there is a destruction of your bowel and the colon is completely messed up by the injury, there is no point of attempting primary repair. If you have less than 50% circumference injury then a primary repair seems reasonable; anything above that then you might want to do either an anastomosis or you want to completely exteriorize that segment.

The surgical site infection ranges from 2.7 to 50% in colonic trauma. This is a huge amount of complication and why is that in this day and age? Everybody worries about wound infection and colonic
surgery in the setting of trauma; you’re probably going to have a high incidence of that. The recommendation is to close the fascia if you can; obviously, if the patient is not in shock and you don’t need to leave the abdomen open and you can close it, close the fascia but leave your wound open. Why is that? Because the infection rate of that wound is so prohibitive that you risk a massive infection and even a necrotizing fasciitis and this is really not worth it. If you have a 29% risk of this happening, why subject the patient to that problem? So, leave the wound open, come back two or three days later, wash it out or close it or wait a few days and let it heal by itself.

What are the alternatives? We already talked about that: simple closure; resection with primary anastomosis; resection with primary anastomosis and proximal diversion (meaning like you think your anastomosis is okay, but you’re not feeling confident about it, you can go in a proximal area of the bowel and give what we call a loop ileostomy or colostomy and this will kind of protect your anastomosis); end colostomy and Hartmann’s pouch (this is an option, too); or the exteriorization with repair and exteriorization of the injury site, which is more of a historical thing -- we don’t use this anymore.

The fecal diversion versus primary repair: You have to do mandatory colostomy if you don’t feel comfortable. This is still a good concept; however, just keep in mind that by giving colostomy a lot of people will have a colostomy which may become permanent. There is no guarantee. If you did this on a 75-year-old male who is borderline and you get your shot at fixing him and you didn’t; you decided to give him a colostomy, he may never want to go back to the OR or it may be too prohibitive as a risk to go back and fix it. So, whenever it’s possible and safe, perform a primary repair.

What are the factors that will make you decide otherwise? Increased age (if you have a 90-year-old patient), you probably don’t want to deal with any leak or complication from sepsis. Your best bet is to give them a colostomy and say, “Hey, you know what? You’ll live another day and we’ll decide what to do. If you have a massive trauma and you have associated organ injuries, there is no point of trying to do a primary repair. Your goal is to get the patient out of there; put him in ICU as soon as possible. If there is a left colonic injury, people still think that the best way to treat this is to perform a colostomy although this is very controversial and we’ll talk about it a little bit later.

Preoperative shock – obviously, if they’re in shock which is usually what’s going to kill the patient because they’re acidic; they have lost a lot of blood; they’re hypothermic; and the repair that you’re going to perform is not even going to be perfused, so no blood supply is going to come to that, you know this is doomed and it’s going to go and fail. So, just avoid that. Give the patient a colostomy and you can come back later if you need to.

Gross fecal contamination -- no matter how much you’re going to clean that abdomen, if there is stool everywhere, the patient is going to have sepsis and go into shock and you’re going to be behind a curve with an anastomosis and a repair that is going to fail and rupture. If you have extensive colonic injuries, obviously you’re not going to waste your time doing that, so just divert, let things cool down, and come back another day. If the bowel, again, is not viable, there is no point.
Rectal trauma -- this is a little bit different and a lot of people... I don’t know if some of you guys make a difference between rectum and colon. The rectum is really the last 15cm of our GI tract and this has a specificity because it’s in a special area called the pelvis where it’s difficult to access and difficult to manage if there is any problem there and the way this is managed is very controversial to this day. It’s very rare to have a rectal injury but when this happens, it’s pretty serious. Back to the historical perspective, there was a mortality of 67% for rectal injuries during World War I; and now we’re down to 0-10%; the morbidity -- 72% in the Vietnam era to 10% nowadays, so you’re talking about a huge improvement that we had over time but if you can look at this, it was huge as far as complication or morbidity.

We don’t have much data; we have not enough class 1 or class 2 data to come up with firm conclusions, so everything we have is kind of good but you cannot go by that for every case and you have to kind of use your judgment as the physician and surgeon how you’re going to manage these patients. The majority of the rectum is surrounded by bony pelvis as we saw it earlier. The uterus --the same thing -- it’s protected. However, it can be a source of problem because of penetrating injuries such as a bullet or shrapnel or other kind of mechanisms and it’s mostly penetrating and rarely due to blunt trauma.

Again, the length of the rectum is about 12-15cm and not all the rectum is exposed in the same manner. The anterior part of the rectum is what we call intraperitoneal and the posterior part is mainly retroperitoneal and the sides are kind of half-and-half. So, if you have an injury to the upper rectum, mid-rectum, or lower rectum, the whole strategy of managing that can be completely different.

This is a side view of the pelvis and what you see here, the intraperitoneal part which is basically almost the same as having a colonic injury because it’s in the same cavity, but if you have an injury lower here, then you’re talking about... you’re not exposing that. If you open the belly here, you’re not going to be able to see that easily. You have to dig to get in there. So, you probably don’t want to manage this injury down here the way you would like to manage it up here.

Again, it’s not very frequent. It’s usually from penetrating trauma. Gunshot or shotgun wounds comprise 80–85% of these injuries. Stab wounds are very rare, 3-5%. Iatrogenic (usually from urologic procedures)... (I hope there’s no urology here); endoscopic injuries from GI doctors and some surgeons here too; and sex-related traumas, obviously; anorectal foreign bodies from personal recreation; and blunt trauma -- mainly from a pelvic fracture, if you’re involved in a car accident and you get your pelvis crushed and you have a piece of bone, it can penetrate your rectum and cause a laceration in there, that’s something to recognize.

How do you do a diagnosis? Again, it depends on the level of your injury -- if it’s higher in the rectum, you’re going to have peritoneal sign because it’s intraperitoneal injury and it’s exactly the same as a colonic injury; but if you have it in the lower part of the sides this could be an extraperitoneal injury which is not always obvious. You may think the patient is just doing fine and you have not recognized this.
So, how do you address that if you have a suspicion of a lower rectal injury -- obviously, an examination which will include a digital rectal examination. Okay, I guess you guys all know what the contraindication of digital rectal exam is, right? Nobody knows? It’s simply no rectum (for people who had surgery and they have the rectum removed); no finger; and no glove; and no glove is relative. Anyway, you have to do basically a digital examination on every one of these patients and you have to carefully palpate the perineum; look for signs of hematoma; signs of pain; or anything that may clue you about an injury. Assess the sphincter function -- you know you can have a patient who is going to say, “Well, you know what, before you did my surgery I was having a good function of my sphincter and now after the surgery I have to wear a poop bag.” Well you have to examine the sphincter, make sure the patient has a good reflex and has a good sphincter tone.

Now, obviously you can’t do that in a patient who is unconscious but at least you should try to attempt and look at the anatomy. You’ll do a vaginal examination and this is only valid for 50% of the population. You’ll also do what we call a “sigmoidoscopy.” Sigmoidoscopy just means looking inside your rectum with some kind of instrument -- it could be a rigid sigmoidoscopy or a flexible sigmoidoscopy and you may be able to identify an injury this way.

Now, barium enema is contraindicated not because we don’t do that; it’s just because if there is really an injury and you give him barium, that barium can seep out into the other peritoneal cavity and make it like a simple case or horrible case. So, we use mainly the water-soluble enema such as Gastrografin®. CAT scan also can be used, again, as an adjunct and it will give you an idea about the trajectory of your bullet or what could have happened because remember, you see an entry wound and an exit wound and you have no clue what happened in between, a CAT scan might be able to give you some information you need to know.

Some historical perspective about the rectal trauma -- World War I we talked about it -- 67% mortality; World War II, again the mandatory army surgeon, colostomy and this decreased the mortality down to 35%; in 1943 there was an addition of a procedure, say, “Well, we’re going to give a colostomy to everybody, then we’re going to do something else, we’re going to put in a retrorectal drain. If you look at the picture I showed you earlier, behind the rectum, the area that cannot be accessed, you will go there and you put drains from close to the anal area and you leave them there and this kind of dropped the mortality down to 5% which is like a huge improvement. Then came the Vietnam war and we started seeing more destructive injuries and they saw that this was inadequate to deal with this patient and really didn’t make a lot of sense, so people started doing rectal repairs and distal washout as an adjunct as well to this strategy.

Again, the intraperitoneal injuries which are the ones on top (the upper part of the rectum) can be managed as any colon injury that we talked about earlier, without need of any colostomy if you don’t have to. And as far as the extraperitoneal (the one in the lower part of the rectum), really there is no great agreement but the mainstay is that you do a fecal diversion with a colostomy (that’s something you can do); presacral drainage; distal rectal washout; and repair of injury if you can. So, these are the four things that you can do.
For the proximal colostomy, there is a debate whether you should go for an end colostomy or a loop colostomy and some surgeons believe if you give a loop colostomy you are not really diverting, some of the stool can still go down. Some of the surgeons say, “Well, if you give a loop colostomy you can still do wash outs.” But I don’t think any of them make any difference.

The information we have of the presacral drainage... it’s been added in World War II. It remained controversial for a while. Until 1998 Gonzalez et al., performed a randomized control study of 48 patients. Again, this is a low number but the best we have. And they saw that presacral drainage versus no drainage really made no difference. It looked good on the picture and the concept that as far as we know the best study we have showed no difference. And over the last 15-20 years people have come and said, “Well, if it’s really not making any difference, so why do it?” And so less and less people are doing that but, again, there’s always an exception to a rule and it is if you have a destructive lesion of the rectum or pelvis and a significant amount of hematoma or destruction, then probably it’s wise to leave a drain in that area anyway.

So, the distal rectal washout which is just putting some kind of tube there and washing your rectum, there is questionable value. We don’t know much about whether it makes anything; we don’t have good study about that either. The rectal repair, the way you could do that with or without diverting colostomy, if you’re going to be able to repair that, it’s very difficult to do in the extraperitoneal which is the lower part of your rectum because let’s say you’ve entered the abdomen; you’ll have to dig very deep; you may lose much blood; and make your patient more sick by going there and trying to repair it. So, you may as well just give him a colostomy and let that repair primarily. However, you can repair it from the anal area -- if it’s low enough within 5cm of your reach, you can possibly go there and repair it transanally.

And that’s all I have to do for that. I’m sorry for taking too much time.

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