

September 3, 2005

Reno.

Dear Bret,

Thank you so much for the very generous gifts. I will not have any excuses for a bad round of golf.

Today the last of the girls went home. So [REDACTED] (PAO) back to [REDACTED] (Femoral neck, distal Femur) to [REDACTED] And [REDACTED] PAO with (S1-2) back to [REDACTED] No real change in deficits, but the beginning of causalgia, symptoms which I have chosen to interpret as a good sign.

The PAO:

"Inner based Smith Peterson" starts along the iliac crest. Dissecting to the inside (false pelvis or iliac fossa) proximally and to the outside, distally, at the level of the anterior superior iliac spine.

Internally rotate the leg to see the fusiform swelling of the Tensor muscle beneath the skin. Follow its mid-portion with the incision to the fat and later, translucent fascial layer looking for the anterior sheath with the subtle outline of the tensor muscle beneath it.

Take the short AO saw blade and make an osteotomy of the anterior iliac spine. Since the medial soft tissues are still attached (Sartorius and inguinal ligament, +/- lateral femoral cutaneous nerve) dissection in the anterior interspinous area will allow it to be retracted medially, and intra-pelvic posterior development of the interval with the periosteal elevator, will make a confluence of the dissection of the internal iliac fossa.

Depending how medial and how posterior you proceed at this step, the Foramen of the iliolumbaris vessel found along the posterior pelvic brim, will start to bleed and require bone wax to quench it.

The Trip To The Anterior Femoral Circumflex Vessels:

Now catching the dissection up distally, The scalpel is deftly and longitudinally drawn across the anterior portion of the tensor sheath, revealing the healthy red brown fibers of the tensor muscle. The muscle is dissected from the medial wall of the sheath, which is facilitated by the tension applied to it by a pair of judiciously applied "Alice clamps" along the medial edge of the sheath.

The floor of the sheath is thereby reached, and displacing the muscle belly laterally with an appropriately bladed Langenbeck retractor, the floor is incised to reveal another aponeurotic layer (that Letournel felt was unrecognized and unnamed by the anatomists) which overlies distally the anterior femoral circumflex vessels and the antero-lateral side of the Vastus Lateralis which now resides as the floor of the exposure. This innominate aponeurotic layer is

carefully divided, releasing the circumflex vessels from their tether. This represents the distal most extent of the dissection for a PAO. Carefully exploring the leash of vessels running transversely across the distal extent of the wound, an ascending branch of the circumflex leash is usually recognized along the medial floor of the exposure, sometimes deep to the fascia overlying the lateral aspect of the medially positioned Rectus Femoris.

It may be cauterized in this location to decrease bleeding in the vicinity of the capsule of the hip, but it will still be seen as a small but constant ascending branch of the anterior circumflex vessel recurrent on the medial side of the base of the wound but residing at a slightly deeper level.

In the vicinity of the anterior inferior iliac spine the anastomosis between the terminal branches of the inferior gluteal and ascending branch of the A.C.A. will cause some bleeding as it enters the innominate bone on the lateral aspect of the anterior inferior spine. This is best controlled by pressing the Bovie into the boney foramen and pressing the button of cutting to coagulate, or once more employing some bone wax pressing it into the foramina.

The Dissection of the Capsular Portion on the Iliacus muscle:

Having identified the terminal portion of the dissection by identifying the A.F.C.V. And having cauterized the ascending branch, it is now time to incise the fascia over the posterior Rectus Femoris exposing a modest space in which resides some fatty tissue and when palpated with the finger reassures the surgeon that he is directly on the capsule with the lower pole of the femoral head beneath the finger's tip!

This incision is propagated in a proximal direction. The dissection proximally is blocked by the obliquely oriented fibers of the Indirect or reflected head of the Rectus Femoris muscle.

This structure, a confidence bolstering sign along the route, is tagged with a hearty suture and transected in such a way as to leave intact the capsule of the hip joint which lies deep to the reflected tendon. (a mistake here would be a too vigorous incision of the tendon that cuts as well the capsule and enters the joint prematurely!) As we lift the transected tendon away from the capsule of the hip and work our scalpel blade tangent to the capsular fiber we will enter another fascial sheath behind which the red-brown fibers of muscle is viewed. This will occur just in front of, or slightly medial too, the anterior inferior iliac spine and anterior wall of the acetabulum.

Looking at the confluence of the newly exposed muscle and

the previously dissected Iliacus, proves that indeed this is the capsular portion of the same muscle (Iliacus). The dissection now proceeds on "solid ground" as the muscle fibers of the capsular portion of the Iliacus muscle are sharply dissected off the capsule of the hip joint. This portion of the exposure of the hip capsule is rapid and efficient.

The Hunt For The Psoas Tendon:

Since medially and proximally, iliacus and psoas fuse to spill out of the pelvis over the low anterior wall of the acetabulum. The underbelly of which is lubricated by a bursa that lies deep to the muscles and superficial to the bone in the "Psoas gutter"; it therefore, makes perfect sense that exposing the capsule from lateral to medial, by way of dissection of the capsular portion of the Iliacus muscle; that with a skilled assistant retracting the dissected Iliacus from the capsule with a Deeever or Langenbeck retractor, that the retraction of the dissected muscle has the effect as to flip it slightly inside out, bringing the psoas sheath into view.

It is now the time that flexion of the Femur in the acetabulum is carried out.

This has the effect to relax psoas and capsule, with the effect that further dissection may mobilize the psoas sheath along the whole exposed portion of the capsule and expose proximally the bursa located on the boney floor at the root of the pubic ramus.

To Place The Mayo Scissors On The Anterior Subcotyloid Surface Of The Ischium:

With the hip Flexed to 60 degrees it is possible to follow the psoas sheath over the anterior capsule to the anterior inferior capsule.

With a Deeever retractor providing exposure medially, and another Deeever laterally enlarging the opening to the OR lights; open the Psoas sheath as it dives over the anterior-inferior capsule.

Now place the closed blunt tips of the Mayo Scissors into this opening between Psoas Tendon and capsule and push inferiorly, lightly.

The scissors should advance forward thru light fascia. Now check the x-rays (positioned on the operating room view box).

The Surgeon must review the AP Pelvis and see where the Ischium is located in relationship to the inferior femoral head. Also, he will wish to note the presence Lordosis, or Kyphosis on the AP Pelvis x-ray.

Advance the scissors, after spreading them a few times times to increase the size of the opening, and then push them down and back to make contact with the Ischium...palpate medially...Obturator Foramina...palpate laterally...

Hamstring origin, lateral Ischium.

Setting Up The First Incomplete Osteotomy:

We haven't visited the exposure in the proximal aspect of the wound for a while, and there are a few things to do prior to cutting beneath the socket.

With the periosteal elevator, expose to the pelvic brim and place an Eva retractor just over it. Now with the "bogen" elevator subperiosteally dissect the Obturator Internus off the quadrilateral plate. Place the reverse Eva with a "large spoon" against the quadrilateral plate and tamponade the bleeding if necessary, with a "Raytec" sponge.

This step clears the soft tissue from the bony medial face of the pelvis, so that it will not be cut transversely by the osteotome during the first osteotomy.

Remember when the retractor is placed against the quadrilateral plate not to let it wander posteriorly into the greater sciatic notch, injury to the sciatic nerve might ensue.

The First Osteotomy:

Position the image intensifier so that the Pelvis Shadow on the fluoroscope is similar to the AP Pelvis from which planning was carried out.

Position the image as well over the involved hip and make sure the pelvic landmarks are visible. Take a controlled view of the uninvolved hip and save it.

Make sure all landmarks can be seen on the oblique view, particularly the greater Sciatic Notch and the ischial spine.

Flex the hip and return to the distal wound and insert the two Deevers as before. Replace the Mayo Scissors as before, and with the closed tips of the Mayo Scissors, feel the Ischium. Remove the Mayo Scissors and pass the "reverse curved Eva retractor" on to the anterior ischial surface. Verification of its location can be obtained by bringing in the fluoroscopy.

When correct, using the reversed Eva as a guide, place the curved 15mm Osteotome on the anterior ischium. With serial image control, strike the osteotome with the Mallet, driving it under the acetabulum and allowing it to rise posterior to the socket, above the level to the ischial spine.

The cut is carried out until there is a full finger's breadth of posterior column in front of the greater sciatic notch that has not been violated. The leg may be steered to allow a different travel of the osteotome.

To rise high posteriorly behind the socket, the leg must be extended so the handle of the osteotome can be directed more to the thigh.

To cut more medial, the leg must be adducted and flexed enough to allow the adductors to be relaxed.

To cut more laterally, slight flexion of the hip, to barter

relaxation of the Hamstrings against relaxation of the iliopsoas must be accomplished.

The relaxed Hamstrings and slight abduction to relax the hip abductors, allows the chisel to cut in the area underneath the posterior facet.

Once the osteotomy is completed beneath the acetabular socket, yet rising well above the ischial spine, (i.e. leaving posteriorly 1.2-2.5 cm of intact quadrilateral plate in front of the greater Sciatic notch).

It is time to turn one's thoughts to the arthrotomy that is needed to check the articular surface of the hip for impingement.

Arthrotomy of the Hip:

After completing the first osteotomy, the next step for me is to carry out an arthrotomy and look for problems that may or may not appear on a pre-operative Arthro-MRI.

Ganz and his co-workers feel that an arthrotomy with the objective of looking for impingement signs at the head neck junction of the proximal femur is necessary. Head neck offset is frequently insufficient in the dysplastic hip, and labral tears both as part of the instability of the dysplastic hip or from impingement are common and if extensive need to be addressed.

Since the capsule has been fully exposed by the last step, an Eva retractor is inserted between the psoas sheath and the medial capsule, medially: and a standard Hohmann retractor inserted posterior laterally underneath the stump of the indirect head of the Rectus.

The capsule of the joint is then opened longitudinally from just above the intertrochanteric crest inferiorly to the labrum superiorly. A "z" shaped capsulotomy is performed by making a transverse distal medial limb, and a curvilinear proximal limb that follows the superior bony attachment of the labrum along the proximo-lateral surface.

In most hips the femoral head will subluxate by a "figure 4" maneuver in external rotation. If the ligamentum teres is ruptured or cut with a scissors or a scalpel a frank anterior dislocation can be achieved.

Although this allows a good exposure of the head and neck for osteochondroplasty, the femoral head blocks too much of the mouth of the acetabulum to allow much work on the labrum or the inside of the socket.

The Second Osteotomy, Osteotomy of the Base of the Pubic Ramus:

In the previous section, called "setting up the first osteotomy" a discussion of the exposure of the anterior column and the quadrilateral plate of the pelvis was described.

The cut on the base of the ischial pubic ramus is a continuum of this exposure and actually aided by the fact

that the acetabular capsule has been opened so one can literally see the end of the anterior extent of the joint (medial aspect of the anterior pectineal eminence). The femur is flexed and adducted. Retraction of the soft tissue parts, Sartorius, Rectus and Iliopsoas is best done with a medium Deeever retractor, while the peri-osteal elevator is worked on the bone to elevate the psoas bursa, and the lateral origin of pectineus from the pubic ramus. A "kinder-Eva" is placed from the inner surface of the pelvis, into the obturator canal to protect the obturator nerve, artery, and vein. A second "kinder-Eva" is placed into the obturator foramina from the external surface of the root of the pubic ramus for the same purpose. The ideal clearance medially is about 1 centimeter from the location of the pubic osteotomy. In this location, a 8mm Hohmann retractor is hammered into the bone. (The reason 1 cm clearance is desired, is so that the Hohmann tip will not "crack" into the pubic osteotomy as it is being made, causing a loss of exposure of the operative field at a critical phase of the cutting of the osteotomy. Once prepared, I indicate the proposed location for the osteotomy with the coagulation portion of the bovie which leaves a mark on the bone. I then use a cutting head on the Anspak* burr to remove the first cortex at my osteotomy site. I then use a straight, or "bayonet" osteotomy to complete the osteotomy. Since there is only one cortex left between a complete or incomplete osteotomy, removing the first cortex with a burr allows increased sensitivity as to when the osteotomy is complete.

The Third Osteotomy: Cutting the Posterior Column:

From the earlier stages, the exposure for the posterior column osteotomy is almost complete. All that needs to be done is to allow the surgeon digital control of the greater sciatic notch thru the true pelvis. Since the quadrilateral plate has already been prepared, this is not difficult. The reverse Eva retractor with a wide spoon is inserted into the true pelvis between the boney quadrilateral plate and the periosteum and the elevated muscle fibers of Obturator Internus. The plan in the usual case is to leave 2-2.5 cm of posterior column anterior to the greater Sciatic Notch intact. This distance is determined by palpation of the greater Sciatic Notch with the long finger. The desired distance is the width of the finger. In addition, the spine of the ischium can also be palpated. Remembering from the earlier discussion, the first osteotomy was designed to ascend above the ischial spine. So in many cases the osteotomy along the quadrilateral plate can be felt with the exploring finger. Once the proper location for the cut is determined it is

marked on the pelvic brim with coagulation from the bovie. It then is digitally reconfirmed. Next the same marked location is removed with the "cutting burr" and palpated once more to be sure it is satisfactory. If so, it is made deeper.

The pelvic brim in this location is composed of extremely hard bone, by cutting the original starting tract of the osteotomy with the burr, the chance of splitting, or causing a unplanned fracture of the bone, in this critical area is avoided.

This osteotomy is then completed to the desired degree by inserting a straight osteotome and recutting the bone in the area previously separated by the burr. It is important to carry this cut enough posteriorly to score the retro-acetabular surface.

The Fourth Osteotomy: AKA The Final Osteotomy:

The final osteotomy will join the posterior column osteotomy, which hopefully, has already joined the first osteotomy, cut as it was, inferior to the joint in front and ascending in the bone behind the joint. To accomplish this osteotomy, the leg is held in slight flexion and abduction. A periosteal elevator is used to tunnel between the Gluteus Medius muscle and the bone in the direction of the posterior column osteotomy.

A reverse Eva retractor with a "narrow spoon" is inserted between the bone and the muscle in the tunnel to protect the soft-tissues from the oscillations of the saw blade.

A thin 7cm long Synthes saw blade is then started on the iliac crest (almost always in the mid-portion of the residual defect left after the osteotomy of the anterior superior iliac spine) and continued across the iliac wing from lateral to medial. It is aimed to intersect the top of the posterior column osteotomy.

Completing the Osteotomy:

Straight osteotomes are then inserted into the posterior column osteotomy and into the iliac wing cut and both are driven toward the end of the cuts with the light blows of a hammer. An angled osteotome is inserted into the junction of the third and fourth osteotomies and aiming for the external surface of the Pelvis above the retro-acetabular surface, is struck with a mallet propagating the clean break in the posterior column on the external surface of the pelvis. Final loosening of the periacetabular fragment occurs when the angled Ganz osteotome is inserted in the posterior column osteotomy and hammered into place, allowing it to angulate anterior once the bend in the osteotome engages with the pelvic brim.

When correct, the periacetabular fragment should be loose and floppy. It should be completely free from all of the surrounding bone.

At this point two 4,5 Schantz Screws into the fragment after drilling with a 3,5 mm drill bit. They are inserted at as close to 90 degrees from one another as possible and fitted with T-handled Chucks. These will be the "joy sticks" that are used to position the fragment.

Positioning The Fragment:

The Fluoroscopic unit is brought in and centered over the Pelvis. The image is rotated until symphysis and coccyx are in alignment and vertically disposed. The table needs to be rotated on its long axis occasionally to line coccyx up to symphysis, completely in the midline of the body.

Next by Orbiting the C-arm cephalically or caudally the obturator foramen are made to match in contour the pre-operative x-ray of the pelvis. The scene is now set to manipulate the articular fragment and control its position in space and within the pelvis with the image intensifier. To correctly position the fragment you must be able to identify the anterior wall of the acetabulum, the posterior wall of the acetabulum, the sourcil or roof shadow. Also the ilioischial line.

The radiological landmarks are best reviewed in Chapter 3 of Emile Letournel's book "Fractures of the acetabulum".

In the end, the correction should be viewed in regard medial-lateral position of the acetabular fragment. Medial femoral head about 1 cm lateral to the ilioischial line in most cases is optimal.

The sourcil should be almost horizontal, 4-10 degree Ace Index.

The lateral shadow of the anterior and posterior walls of the acetabular fragment should intersect at the lateral margin of the pelvis. And the LCE and ACE should be "normalized" in the amount of ~ 25 degrees. Adduction of the fragment is read by observing the change in the angular relationship of the iliac wing cut surfaces one to the other, while extension can be judged by viewing the triangular shaped gap between wing fragments when viewed from the side. Version is judged by the angular relationship of the wing fragment above and below the osteotomy cut viewed from above. This may also be checked by the changes in the fragment in relationship to intact pelvis the along the pelvic brim.

All of these intra-operative findings are verified by viewing the fluoroscopic or x-ray image!

The part of the acetabular fragment that projects anteriorly and laterally or slightly medially, may be trimmed and this relatively large fragment, cut into the appropriate shapes that may be used for bone graft, filling the angular gaps created by the correction of the articular fragment.

Fixation of The Periacetabular Fragment

Fixation varies Surgeon to Surgeon, but each has pretty much his own pattern of using the screws needed to fix the fragment.

I use temporary fixation with 2,5 mm Kirschner wires from the crest of the innominate bone into periacetabular fragment. I spread them out so that they have good purchase in the bone, and provide good stability of the fragment. The first definitive screw that I use is the anterior to posterior screw, in my hands, is a 4,5 mm screw usually 110-130 mm in length. It runs across the periacetabular bone to travel between the two tables of the ilium toward the posterior inferior iliac spine. Do not inadvertently enter the SI joint.

The 2.5 mm K-wires used for temporary fixation, if in good position, are removed and their hole enlarged to 3,5 mm. Into this a 3,9 mm locking bolt of appropriate length is inserted, (usually 80mm to 110mm). I use these because you can always get them out later. Alternatively, in thinner bone the 3,5 mm cortical screw is used; in which case, the hole remaining after extraction of the 2,5 mm K-wire may be used definitively.

The problem with the 3,5 mm cortex screws, in such long length, is the heads frequently strip or the screw breaks at the head neck junction when an attempt is made to remove them after the osteotomies are healed. Removing them after this kind of occurrence is very difficult.

The Hip capsule is then closed with interrupted suture, the indirect head of the rectus is reattached to its stump. The rectus head is placed to bone with anchored suture.

Finally the ASIS fragment is reattached to the anterior pelvis with two 2,7 mm screw, usually in lengths of 45-55 mm.

The Tensor sheath is closed, taking care not to loop the lateral femoral cutaneous nerve in the closure. The abdominal wall is then repaired over the iliac crest. Subcutaneous sutures are placed and the skin closed with intracutaneous 4,0 Monocryl Suture.

Final x-rays are obtained while the patient is still asleep and consists of AP Pelvis, AP involved hip, and simulated Faux profil lateral