A 23-year-old Hispanic male sustained a single gun shot wound (GSW) to the left upper buttocks. He arrived to the Emergency Room in hemorrhagic shock with a systolic blood pressure of 73 and heart rate of 120. The patient had a patent airway, good breath sounds with adequate excursion but peripheral pulses were weak. He was able to move all extremities to command but was intermittently obtunded. There was a single GSW just above the left buttocks 5 cm lateral to the midline. The patient had diffuse abdominal tenderness and was in persistent shock. He was taken emergently to the operating room. No adjunct studies were performed in the Emergency Department except for the Focused Abdominal Sonography for Trauma examination that was positive for fluid.

Approximately 2 L of blood was evacuated with lap pads at exploration. The bullet was retained in the low anterior abdominal wall on the ipsilateral side of the posterior GSW. There was continued active bleeding from deep within the pelvis. His aortic bifurcation and iliac veins were compressed but this did not arrest his bleeding. Venous bleeding continued from bony and soft tissue destruction. It was not well controlled with pelvic packing, gelfoam packing, Foley catheter balloon tamponade, and iliac vein ligation. Bilateral internal iliac artery ligation was performed but the bleeding remained significant from a large bony defect. The patient continued to be hemodynamically unstable despite continued transfusions of red cells (15 units ultimately) and fresh frozen plasma. The decision for damage control laparotomy had been made early in the procedure but the pelvic bleeding eluded attempts at even reasonable surgical control for temporary closure and resuscitation. The left ureter had been identified and was found to be without apparent injury.

Because the patient had continued bleeding that was not controlled by conventional means, and the patient’s clinical status was continuing to decline, one pack (1.75 oz.) of QuikClot, Absorbent Hemostatic Agent, was deposited in the large defect and packing was applied. This maneuver resulted in almost instant arrest of significant pelvic bleeding. There was a rapid improvement in hemodynamic parameters; however, the patient remained cold and coagulopathic. The remainder of the pelvis was packed and the uninjured left ureter was placed back in its normal position before the abdomen was temporarily closed and the patient transported to the Surgical Intensive Care Unit.

The patient’s coagulopathy was corrected, there was no continued clinical bleeding and the patient’s physiologic parameters were more normal within the first 24 hours postoperatively. He was returned to the Operating Room where his packs were removed. There was only minimal bleeding noted. The remaining QuikClot was removed but there was a moderate amount of material left adherent to the surrounding tissues and deep within the pelvis. QuikClot was adherent to the ureter near the original injury site but it did appear intact. Tissues that were in contact with the material were viable. The patient did well postoperatively. He was transferred to the floor by postoperative day POD 2. He did not have evidence of bleeding and he complained only of left sided back and leg pain which was present preoperatively. He was tolerating a diet and was discharged on postoperative day 7.

He was seen in a clinic visit and reported no other problems except for left sided back and leg pain as before. However, approximately 3 weeks postoperatively, he was evaluated and admitted for abdominal pain. Computed Tomography (CT) of the abdomen revealed left hydronephrosis and dilated ureter (Fig. 1). No ureteral extravasation was detected on CT. He was subsequently evaluated by urology and diagnosed with a ureteral injury with leak on anterograde cystourethrogram (Fig. 2). A nephrostomy tube was placed. Stent placement was attempted but was unsuccessful because of the size of the defect. Plans were made for elective operative repair.

Two weeks later, he was evaluated emergently for abdominal pain and blood per his nephrostomy tube. He was found to have a hemoglobin of 7.2 g/dL (postoperative hemoglobin was 9.4 g/dL). He was found to be only in mild
distress with normal vital signs and blood tinged urine per nephrostomy. Abdominal CT scan showed a pseudo-aneurysm in the left pelvis (Fig. 3). Subsequent angiography showed reconstitution of a branch of the left internal iliac artery via a lumbar artery that fed the pseudoaneurysm (Fig. 4). This reconstituted left internal iliac branch was coiled with resolution of the pseudo-aneurysm (Fig. 5). He was discharged uneventfully and rescheduled for elective ureteral repair.

He was taken back to the operating room approximately 7 months after his initial injury and explored. The left pelvis had extensive dense adhesions. The left ureter was tightly adherent to this reactive tissue. After tedious dissection, the ureter and bladder were identified and a psoas hitch ureterocystostomy repair was performed. He was discharged after an uneventful postoperative course, has not been re-admitted and appears well in follow up clinic visits.

**DISCUSSION**

This patient sustained a potentially lethal GSW to the pelvis and would have died if his bleeding was not controlled. This case report chronicles the success of intracorporeal use of Quikclot to arrest severe bleeding but also a very signifi-
cant complication. Quikclot is a zeolite mineral and is sold as a sterile, biologically inert granular material that is highly hydrophilic. Contact with blood initiates an exothermic reaction with local tissue surface temperatures reaching as high as 90°C. Its main mechanism of action is rapid concentration of clotting factors and platelets at the site of wounding via almost instantaneous absorption of the fluid component of blood. Swine studies confirm a marked survival advantage with the application of Quikclot compared with conventional dressings after femoral vessel transection.1,2

There has been concern that its prolonged contact with human tissues will precipitate severe burns and extension of the injury zone. Animal studies document this well.3 Thus far, this complication does not represent a significant problem when compared with its ability to arrest bleeding in complicated cases. However, due in part to these concerns, Quikclot is not yet recommended by the manufacturer for intracorporeal use. Despite this, there are case reports of its use in both intrathoracic and intra-abdominal injuries where they have been used with success.4 In this case, the users had exhausted all conventional means of surgical control and used QuikClot in a last resort, life saving maneuver with knowledge of potential complications.

There is a possibility that this patient’s ureteral injury was caused by the initial GSW but we did not think that this likely. We were able to identify the ureter in the area of pelvic injury and there was no injury at the initial exploration. There was a sizable section of the distal ureter that was injured and this was more likely due to inadvertent prolonged contact with Quikclot. We speculate that the heat produced by its application resulted in tissue coagulative necrosis and fibrosis leading to stricture and subsequent ureteral rupture at some time after the first exploration. This was likely present at the take back procedure but was not appreciated due to adherent material. We do not, however, have histologic evidence of this process but the absence of injury before the application of QuikClot and its mechanism of action makes it likely the culprit. The urologic trauma service was able to reconstruct continuity of the collecting system but only after extensive workup and tedious dissection. This complication caused a prolonged follow-up and represented substantial resource utilization despite the patient’s ultimate outcome.

The development of a pseudo aneurysm could have been due to injury of a vessel secondary to coagulative necrosis of the exothermic reaction with zeolite or an inflammatory response but this is less likely than simple reconstitution of flow to an injured internal iliac artery via a lumbar vessel. We think that this complication was unfortunate but not strictly related to intracorporeal use of Quikclot.

In summary, we present a case of intracorporeal use of Quikclot that was likely life saving but caused a serious complication. The use of QuikClot should generally be restricted to external wounds and its use in any intrathoracic or intra-abdominal injury should be done only as a last resort life saving maneuver with full understanding and vigilance for its complications.

REFERENCES


