Transcatheter Embolization for Massive Posttraumatic Pelvic Hemorrhage

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The purpose of this study was a retrospective review of patients treated by transcatheter embolization for management of life-threatening pelvic hemorrhage due to trauma. Sixty-one patients with suspected significant pelvic hemorrhage from trauma were referred for arteriography and consideration of embolization. The etiology was blunt trauma in 56 patients (92%) and gunshot wound in 5 patients (8%). Embolization followed selective arteriography in 37 patients (61%). Embolization was performed using coils, coils and Gelfoam, or coils and polyvinyl alcohol sponge particles in all cases.

Of the 37 patients embolized, causative arteriographic lesions were identified in 32 patients (86%). In 5 patients, only minor vascular abnormalities were identified, but coupled with clinical findings, empiric treatment was warranted. Thirty-four of 37 patients (92%) stabilized hemodynamically after embolization. Two of the 34 had recurrent hemorrhage, which was permanently arrested by re-embolization. In 3 of 37 patients (8%), exsanguination occurred before embolization was completed. All had significant delays in recognition of pelvic hemorrhage as the source of hemodynamic instability.

Transcatheter embolization is safe and effective in our experience. We attribute the three deaths to delay in recognition of pelvic hemorrhage as the cause of hemodynamic instability, not failure of embolization.

Pelvic hemorrhage commonly results from trauma and can be massive and uncontrollable, a life-threatening emergency. Techniques for control of pelvic hemorrhage have been utilized with varying degrees of success, including laparotomy with hypogastric artery ligation (1-4), external skeletal fixation (5-8), pneumatic anti-shock garments (PASG) (9, 10), pelvic arteriography with selective embolization (11-14), and even hemipelvectomy (15). Although there are advocates for each technique, optimal outcome mandates an aggressive multispecialty approach with careful attention to the patient's current condition and prompt intervention when indicated. The consequences of indecision are catastrophic. Delays in decision making result in hypotensive, coagulopathic patients refractory to all intervention upon arrival in the operating room or angiography suite. As a consequence, we advocate that initial conservative therapy (fluid/blood products, PASG, external fixation) be followed quickly by diagnostic arteriography and embolization. This is especially important if more than 4 units of blood within a 24-hour time period are administered (16). We present the results of our approach to the management of life-threatening pelvic hemorrhage from trauma using transcatheter embolization.

PATIENTS AND METHODS

All patients who had undergone diagnostic arteriography for suspected pelvic hemorrhage during the past decade were identified. Chart review was performed for each. The mechanism of injury, age, sex, vital signs, angiographic findings, injury severity score, fracture patterns, and therapeutic findings were recorded.

Aortography and selective bilateral internal iliac arteriography were performed. Standard angiographic catheters and/or microcatheters were used with the corresponding size stainless steel coils and/or microcoils. Coils alone were typically used, but if they did not terminate hemorrhage or antegrade flow, either Gelfoam or polyvinyl alcohol (PVA) particles were added. Gelfoam was used in the form of pledges, and PVA particles were of the 700- to 1,000-μm size.
RESULTS

A total of 61 patients underwent diagnostic arteriography because of suspected massive pelvic hemorrhage secondary to trauma. There were 41 males (67%) and 20 females. Their ages ranged from 15 to 88 years (mean = 33 years). The specific site of hemorrhage was identified in 32 of the 61 patients (52%). In 5 of these 32 patients, the site was only at an anterior pelvic location; 1 patient had both anterior and posterior sites; and in the remainder (26 patients), the sites were only at posterior pelvic locations. Sites included areas of active extravasation (23 patients), pseudoaneurysm (3 patients), arterial occlusion (6 patients), or severe contour irregularities (3 patients). Of the 32 patients with site-specific vascular injury, no pelvic ring injury was detected in 2, isolated anterior ring injury was present in 1, isolated posterior ring injury was found in 10, and combined anterior/posterior pelvic ring injury was noted in 19 patients. Five patients were embolized with none of these vascular findings. Two of these 5 patients were observed to have active bleeding on computed tomographic (CT) scans performed immediately before arteriography. The remaining 3 patients were embolized because of the presence of pelvic fractures, adjacent minor vessel abnormalities (irregularity, displacement), and hypotension. In all, embolization was undertaken in 37 of the 61 patients (61%). Coils alone were used in 29 (78%) patients, with an average of 3.3 coils/site (range = 1–10). Microcoils were used only in two of these patients. Coils plus a particulate agent were used in 8 patients (22%).

Hemodynamic stabilization was achieved before discharge from the angiography suite in 34 of 37 patients (91%). In the three unsuccessful cases, the patients died before completion of embolization. All three patients had arrived at the angiography suite in extremis, during resuscitation efforts. Two of these patients had initially been taken to the operating room, causing a significant delay in arrival to the angiography suite. Embolization was in progress in all three when cardiovascular collapse occurred. None could be resuscitated.

Among the 34 patients successfully embolized, 32 had no further pelvic hemorrhage (94%). In 2 patients (6%), both of whom suffered from a persistent coagulopathy, hemorrhage recurred, necessitating a second embolization. In both instances, repeat embolization was successful. Overall, completed embolization was initially successful 94% of the time and 100% of the time after a second embolization. One patient had a minor complication during embolization. Two coils were malpositioned: one was successfully retrieved, but the second was left in a branch of the profunda femoris artery without sequelae. Among the 61 patients, there were a total of 17 deaths (28%). Fifteen of the 17 deaths (88%) resulted from causes other than pelvic hemorrhage: brain death (6 patients), multisystem trauma (4 patients), multiorgan failure (4 patients), and intercurrent myocardial infarction (1 patient).

DISCUSSION

Mortality due to massive pelvic hemorrhage is high (up to 25%) (17–22). Although it is held by some that hemorrhage from pelvic fractures results primarily from venous bleeding (23, 24), a study which utilized postmortem arteriography followed by dissection of the internal iliac arteries showed extensive arterial injury after pelvic fractures, particularly of the posterior elements (25). Margolies et al. (26) introduced embolization of the internal iliac arteries in 1972. Previously, such hemorrhage was treated by volume replacement and/or surgical intervention. Internal iliac artery ligation was at one time widely advocated for unstable patients sustaining pelvic blunt force trauma (1–4). Overall mortality rates reported after pelvic fractures range from 9% to 30% (27), with the mortality of the subgroup with massive pelvic bleeding ranging from 67% to 83% (12, 22).

At our institution, coils are our first choice in most cases. The ease and speed of placement and the assurance of proximal occlusion led to this choice. Embolization is performed either in the proximal internal iliac artery or the proximal aspects of the anterior or posterior divisions. More distal embolization, particularly using small, particulate material, is more likely to lead to tissue necrosis (28, 29). An angiographic study of collateral flow after surgical internal iliac ligation demonstrated prompt, albeit slowed, flow to the pelvic region (30). This observation raises the concern that proximal embolization may not be adequate, but this fear has not been borne out in our series. In our patients with hypotension and evidence of active bleeding at angiography, dramatic—and often immediate—improvement in clinical status followed embolization with coils. The use of Gelfoam or PVA particles was reserved for a minority of patients in whom cessation of flow was not achieved after the placement of coils alone. The risk of tissue necrosis was thereby minimized and not observed in any of our cases.

Since the initial description of embolization for pelvic hemorrhage in 1972 (26), several retrospective reports of studies involving between 6 and 29 patients have been published (12, 13, 31–35). The cumulative data from these reports are summarized in Table 1. The data from our series of 61 patients confirm that hemostasis is achieved in the vast majority of pa-

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