REVIEW / Genito-urinary imaging

Current role of transcatheter arterial embolization for bladder and prostate hemorrhage

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Abstract
Intractable hematuria from the bladder or the prostate can be life-threatening and its management remains a difficult clinical problem. Severe bleeding can arise as a result of radiation cystitis, bladder carcinoma, cyclophosphamide-induced cystitis, severe infection, transurethral resection of the prostate and prostate cancer. When irrigation of the bladder through a three-way catheter and fulguration of the bleeding lesions fail to stop the hematuria, a life-threatening situation can develop, when blood transfusion fails to keep pace with the rate of blood loss. Patients with massive uncontrollable hematuria are often elderly and unfit for cystectomy as a treatment. Many urologists have had to manage this difficult problem, and several different treatments have been attempted and described, with varying degrees of success. Transcatheter arterial embolization of the vesical or prostatic arteries is occasionally indicated in these patients when all other measures have failed. There is limited published experience with this procedure, but success in 90% of patients is reported when the vesical or prostatic arteries can be identified. The aim of this review is to describe the current place of transcatheter arterial embolization in the management of severe bladder or prostate bleeding after failed conservative therapy, and to review its efficacy and morbidity.

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Intractable hematuria from the bladder or prostate is a potentially life threatening event that raises major therapeutic challenges. Causes of severe hematuria include mainly unresectable bladder carcinoma, radiation cystitis, cyclophosphamide-induced cystitis, transurethral resection of the prostate and prostate cancer. In many patients bleeding cannot be adequately controlled by conservative measures, such as irrigation with formalin, silver nitrate or alum solution, intravesical hydrostatic pressure, hyperbaric oxygen or endoscopic diathermy [1,2]. Radical surgery is not always feasible since the operative risk is high in this patient population. Angiography with embolization is a minimally invasive procedure that is emerging as a safe, effective means to control bladder or prostate bleeding. Indeed, vesical or prostatic arteries embolization is occasionally indicated in these patients when all other measures have failed. Despite limited published experience with this procedure, success in 90% of patients is reported when the vesical or prostatic arteries can be identified [3–9]. The aim of this article is to review the main techniques of embolization in such a setting and to review the outcomes of this procedure.

### Bladder and prostate arterial supply

Supplying the bladder, the inferior vesical artery is located in the pelvis. It is a branch of the internal iliac artery, which commonly comes together with the middle rectal artery in the anterior division. Blood from this artery is delivered to the fundus in the bladder [10]. The prostate and seminal vesicles are supplied by the inferior vesical artery in males. It is compared to the vaginal artery in females. The two are considered to be homologous. For some authors, the inferior vesical artery is considered to be found in both males and females, making the inferior vesical artery an artery that branches off of the vaginal artery in women [10]. This artery may have a common trunk with the superior gluteal and internal pudendal, or can branch off from the internal pudendal. This varies in humans, and usually occurs as only one additional branch. The inferior vesical artery also supplies the ductus deferens, which is a section of the sperms’ passageway. The superior vesical artery supplies numerous branches to the upper part of the bladder. Other branches supply the ureter. The first part of the superior vesical artery represents the terminal section of the previous portion of the umbilical artery (fetal umbilical artery) [10,11].

Prostatic arteries have highly variable origins between the left and right sides and between patients, and most frequently arise from the internal pudendal artery. Indeed, the prostate has a dual vascular arterial supply: a cranial or vesico-prostatic artery (named anterior-lateral prostatic pedicle) and a caudal prostatic artery (named posterior-lateral prostatic pedicle). These 2 prostatic pedicles may arise from the same artery in patients with only 1 prostatic artery (found in 60% of pelvic sides), or may arise independently in patients with 2 independent prostatic arteries (found in 40% of pelvic sides). The anterior-lateral prostatic pedicle vascularizes most of the central gland and benign prostatic hyperplasia nodules, frequently arises from the superior vesical artery in patients with 2 independent prostatic arteries [11]. The posterior-lateral prostatic pedicle has an inferior or distal origin, vascularizes most of the peripheral and caudal gland, and may have a close relationship with rectal or anal branches. In up to 60% of cases considerable anastomoses may be seen between the prostatic branches and surrounding arteries that should be taken into account when planning embolization [10,11]. The main arterial variations in bladder and prostatic vascularization are shown in Fig. 1.

### Embolization procedure

Conditioning of patients is important before embolization can be considered. Indeed, initial intervention should include patient resuscitation and optimum hydration, bladder irrigation with clot evacuation and blood transfusion when indicated.

Pelvic endovascular procedure is usually done using local anesthesia with a digital subtraction angiography unit. Retrograde percutaneous catheterization of the femoral artery is performed on 1 or 2 sides using a 5Fr or 6Fr sheath. Then, selective angiography of the internal iliac arteries is done routinely using a 5Fr Cobra or Simmons-type 2 catheter to

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**Figure 1.** Schematic drawing of the different origins of the vesical and prostatic arteries.
delineate the pelvic arterial anatomy. The Simmons catheter tip is then placed as subselectively as possible into the anterior division of the internal iliac artery to opacify its branches. Vesical and prostatic arteries can arise as discrete branches of the anterior division of the hypogastric artery, as previously mentioned, as well as branches from the pudendal arteries in men and from the uterine arteries in women. Abnormal hypervascularity or even a mass may be seen at angiography, but visualization of extravasation is unusual. Based on angiographic findings superselective catheterization of the vesical or prostatic branches is routinely done using a 3Fr coaxial microcatheter.

Flow directed embolization is usually achieved using polyvinyl alcohol particles or tris-acryl gelatin microspheres mixed with contrast medium (Fig. 2). Typically 300 to 500 μm particles are used initially. As the distal branches fill, larger particles (usually 500 to 700 μm) are released (Fig. 3). In patients with angiographic evidence of contrast extravasation, a sign of active bleeding, distal embolization of the feeding branch can be done with n-butyl-2-cyanoacrylate surgical glue mixed with ultrafluid lipiodol in a 1:3 ratio to make the embolization material radiopaque (Fig. 4).

Occasionally when the vesical or prostatic arteries cannot be selectively catheterized, coil blockade is done. This technique consists of occluding a distal branch at its ostium while preserving flow in the vesical or prostatic branches to steer the particles into these branches and protect the proximally embolized territory from distal particulate embolization. Coil blockade is then performed using 0.018-inch fibered or soft platinum microcoils of various lengths and diameters [9].

When the main distal branches of the anterior division of the internal iliac artery cannot be catheterized subselectively, the catheter tip is left in the anterior division of the internal iliac artery and embolization is done at this point using 0.035-inch steel coils of an appropriate size or mechanically disrupted absorbable gelatin sponge powder sheet regardless of whether bleeding was detected by angiography (Fig. 5) [6,7]. Sometimes even when the bladder or prostate arteries were selectively catheterized and embolized, all anterior branches can be subsequently embolized. As needed, the same procedure is repeated on the opposite side via an ipsilateral or contralateral puncture. Main techniques of bladder embolization are described in Fig. 6.

**Brief literature review**

Earlier studies suggest a higher risk of re-bleeding after unilateral embolization [12,13]. Rebleeding after unilateral embolization is probably related to the rich collateral blood supply to the internal iliac artery from the contralateral internal iliac, inferior mesenteric, external iliac and femoral arteries. To prevent rebleeding from these collaterals the anterior division of the internal iliac artery should probably

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**Figure 2.** Right and left vesical arteriograms in an 18-year-old woman with cyclophosphamide-induced cystitis obtained before (a and b) and after (c and d) superselective embolization with 300-μm to 500-μm calibrated tris-acryl gelatin microspheres. The bleeding was successfully controlled, and there were no complications.
be embolized bilaterally regardless of whether the bleeding site is detectable on angiogram [7,8,14–16]. Outcomes in main series are described in Table 1.

The influence of the type of embolic agent on clinical outcomes is controversial. In most previous series the number of patients was too small to allow conclusions about the best embolic agents [6–9,17]. Although authors have used various embolic materials with time, current preference is permanent particulate embolic agents, such as calibrated tris-acryl gelatin microspheres. With gelatin sponge particles recanalization may develop after 2 to 3 weeks [18]. When superselective catheterization is not possible, the distal arterial territory can be protected by placing coils immediately distal to the branches requiring embolization.

Figure 3. Pre-embolization right (a) and left (b) arteriograms in an 80-year-old man with bladder cancer showing increased vascularity of the bladder. Hematuria was controlled after bilateral superselective embolization of the superior and inferior vesical arteries with 500-μm to 700-μm permanent particles. Note the decrease in bladder vascularity (c and d).

Figure 4. Images from a 66-year-old man with massive bleeding post-transurethral resection of the prostate. Angiography showing arterial approach of left hypogastric artery with a standard catheter followed by superselective catheterization of left prostatic arterial branches with a microcatheter (a). Active bleeding was confirmed and stopped by using glue (Glubran/Lipiodol mixture with 1:3) with respect to collaterality (b).
Figure 5. Images from an 81-year-old man with bleeding caused by extensive prostate cancer. Selective right (A) and left (B) internal iliac arteriograms showing increased vascularity in the pelvic area from several small feeding arteries arising from the anterior division of the internal iliac arteries. Angiogram after bilateral proximal coil embolization: complete occlusion of the branches of both anterior divisions (C and D). Flow to the posterior division is maintained despite coil migration on the left. The course was uneventful.

Figure 6. Main techniques of bladder or prostate angiographic embolization: superselective embolization, coil blockade technique, selective embolization.
Table 1  Published series of angiographic embolization for refractory bladder or prostate hemorrhage that included > 5 patients during a 30-year period.

<table>
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<tr>
<th>Study Year</th>
<th>Patient No./Age (years)</th>
<th>Technical success (%)</th>
<th>Superselective embolization (%)</th>
<th>Bilateral embolization (%)</th>
<th>Clinical success (%)</th>
<th>Complication rate (%)</th>
<th>30-day mortality (%)</th>
<th>Late rebleeding (%)</th>
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No.: number; NA: not available.
This technique is helpful when a tumor has recruited several small collateral feeding vessels from the branches of the internal iliac artery. It can help prevent ischemic complications.

**Clinical indications**

Severe hematuria that persists despite conventional treatment raises major therapeutic challenges. Patients are usually older and have radiation cystitis, cyclophosphamide-induced cystitis, or inoperable bladder or prostate cancer with bladder invasion and advanced disease. Prolonged or repeat hospitalization for bladder irrigation and multiple blood transfusions are not practical and the risk of major morbidity associated with radical surgery is often unacceptably high. Endovascular embolization is a minimally invasive method that allows the patient to stay at home without catheters. Most studies of endovascular embolization for severe hematuria are small case series but the technical success rate is high ranging from 92.6% to 100% [3–9,16]. Embolotherapy can provide at least short-term success adequate to improve quality of life for palliation with few complications. Indeed, the initial clinical success can be very high, especially in the most recently published studies in which superselective embolization was performed in most patients, supporting the use of this technique in such a setting [8,9,16]. Repeat bleeding seems to be more frequent in case of radiation cystitis, mainly because patients live longer [9]. Furthermore, refractory hematuria with radiation cystitis, which is characterized by generalized telangiectatic dilatation of mucosal vessels, may be a more difficult, challenging situation. These findings suggest that repeat embolization may be required in patients with radiation cystitis. Hemorrhage can also occur during or following transurethral resection of the prostate and is usually easily treated with unilateral selective embolization [9].

**Potential complications**

Embolization with particles has a small risk of bladder infarction due to the rich blood supply of the organ. Types of complications reported are cases of post-embolization syndrome treated with symptomatic medication. Others have reported cases of buttoc or perineal pain, Brown-Sequard's syndrome because of the prevalence of anastomoses between the vesical arteries and the sacral lateral arteries which has to be checked during angiography, bladder necrosis, gluteal paresis or skin necrosis [4,6,15,19–23]. Most of these groups did not use superselective embolization and had an ischemic complication rate of up to 68.5% [15]. Superselective embolization of the bladder or prostate arteries should be performed whenever possible to minimize the risk of ischemic complications at other sites of the internal iliac territory. In recent studies, superselective embolization was used preferentially and complication rates were low at around 10% [8,9,16].

Of course, the mortality rate and follow-up after embolization are usually relatively high and short in most studies, since the target population is composed chiefly of older individuals with advanced malignancy [8,9,16]. However, the mortality is rarely due to rebleeding and embolization obviates the need for radical surgery in more than ninety-percent of patients. Furthermore, early rebleeding can be controlled by a repeat and more aggressive embolization. Outcomes in main series are described in Table 1.

**Conclusion**

In summary, transcatheater arterial embolization is feasible and safe to control bleeding from the bladder or the prostate after failure of conservative management, whatever the etiology. In most cases, embolization is a well-tolerated procedure that obviates the need for surgery. Embolization should be viewed as a minimally invasive, palliative measure. Indeed, embolization controls the immediate problem of life-threatening hemorrhage and provides sustained bleeding control, contributing to improve palliative care and quality of life by decreasing the need for blood transfusion, bladder irrigation and repeat cystoscopy. Every effort should be made to perform embolization bilaterally and as selectively as possible with permanent particulate embolic agents.

**Disclosure of interest**

The authors declare that they have no conflicts of interest concerning this article.

**References**


