Radionuclide Assessment of Penile Corporal Venous Leak Using Technetium-99m-Labeled Red Blood Cells

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In an attempt to evaluate penile corporal venous outflow, a method that utilizes intracorporal injection of Tc-RBC was developed and used in 20 patients with erectile dysfunction. Seven patients showed venous leak and 13 had normal venous outflow. Technetium-labeled RBC corporal clearance in the flaccid state and after intracorporal injection of papaverine (30 mg) and regitine (1 mg) were assessed in sequence by two separate injections of 18.5 MBq of Tc-RBC each. The time for 50% corporal clearance (T50%) was determined from the time activity curves obtained in flaccid state and after intracorporal injection of the vasoactive agent. There were no statistically significant differences in T50% measured in the flaccid state between normal venous outflow (202 ± 139 sec) and venous leak (92 ± 35 sec, p = 0.1). However, after intracorporal injection of papaverine and regitine a significant increase in the T50% was noted in normal venous outflow (2892 ± 4499 sec) as compared to venous leak (213 ± 123 sec, p < 0.001). The results suggest that measurement of corporal clearance of Tc-RBC after intracorporal injection of papaverine may be a useful method in detecting venous leak, and could be used as a screening test in patients with erectile dysfunction.


The most common organic cause of impotence is vasculogenic and results from arterial insufficiency and/or incompetence of the veno-occlusive mechanism (venous leak) (1). Nuclear medicine techniques have been used in the evaluation of patients with erectile dysfunction. Radiotracer penile plethysmography measures intrapenile blood volume during pharmacologically-induced tumescence (2,3). It has been reported to be useful in detecting arterial insufficiency, but not venous leak (3). The 133Xe washout method has also been used to evaluate penile blood flow. Although it has been demonstrated that delayed xenon washout after subcutaneous injection is a good indicator of arterial insufficiency (4,5), the intracorporal xenon washout method has been shown unreliable in the prediction of venous leak (6,7).

In an attempt to quantitate corporal venous drainage, a technique that measures the clearance of Tc-RBC from the corpora was developed. The present study evaluated the clearance of intracorporally injected Tc-RBC in patients with normal venous outflow and in patients with venous leak. The study was performed both in the flaccid state and after intracorporal injection of a vasoactive agent in order to assess the ability of the method in detecting venous leak.

MATERIALS AND METHODS

Patient Population

A radionuclide study of corporal venous outflow was performed in 20 patients with erectile dysfunction. All patients underwent a comprehensive evaluation by a careful history and physical examination, hormonal and neurological tests, penile-brachial pressure index (PBI), papaverine test and dynamic infusion cavernosometry and cavernosography (DICC). Their ages ranged from 28 to 63 yr (mean = 45 yr), with symptoms of impotence varying from 8 mo to 10 yr (mean 4 yr). Seven patients showed venous leak as a cause of erectile dysfunction. None had evidence of arterial insufficiency with a PBI ≥ 0.86. The remaining 13 patients had normal venous outflow and the causes of erectile dysfunction were neurogenic (n = 7), psychogenic (n = 5) and arterial (n = 1).

Radionuclide Study

The radionuclide study of the corporal venous outflow was carried out in the flaccid state and after intracorporal injection of a vasoactive agent (papaverine 30 mg and regitine 1 mg). With the patient in the supine position, a 21-gauge butterfly needle was placed in the mid-portion of the corpora and the patient was allowed to rest for 10–15 min to reduce anxiety. The dynamics of corporal venous outflow were studied with the detector of a digital gamma-camera (Apex-415, Elscint-Haifa, Israel) imaging the pelvis in the anterior view. Previously prepared Tc-RBCs (18.5 MBq) using the in-vitro technique (8) were injected via the intracorporal needle and data acquisition with computer images of 1 frame/15 sec was recorded for 20 min. At the end of acquisition in this flaccid state, the vasoactive agent was slowly injected via the same intracorporal needle for approximately 1
activity curve of Tc-RBC corporal injection. The Journal

FIGURE 1. Time-50 The Journal

obstruction after pelvic trauma. The T50% of this patient

normal venous outflow (bot-

nous outflow in the flaccid state (baseline) and after intracorpo-

Venous Leak

A rapid clearance curve was found in these patients both in

VI.

DISCUSSION

Normal penile erection requires relaxation of the smooth muscle of the corpus cavernosum, adequate arte-

rial inflow and reduction of venous outflow (1). Relaxation

of the smooth muscle of the corpus cavernosum allows

expansion of the lacunar spaces. Dilatation of the cavern-

ous and helicine arteries increases the blood flow to the
dilated lacunar spaces. The filling and distention of the
lacunar spaces against the tunica albuginea results in the
compression of the subterminal venous plexus reducing
corporeal venous outflow with entrapment of blood within
the corpora leading to erection (1). Incompetence of these
veno-occlusive mechanisms (venous leak) has been rec-
ognized as a common cause of erectile dysfunction with
reported incidence varying from 25% to 78% (9).

The usefulness of flow, volume and pressure measure-
ments for the evaluation of vasculogenic impotence in the
flaccid state has long been recognized, and the introduction
of intracorporal injection of papaverine as a diagnostic
tool allowed the functional evaluation of erection (10,11).

Papaverine is a nonspecific smooth muscle relaxant
which, when injected intracorporally, augments penile

FIGURE 2. T50% measurements in venous leak and normal venous outflow in the flaccid state (baseline) and after intracorpo-
ral injection of a vasoactive agent (papaverine).
blood inflow, activates the veno-occlusive mechanism and eventually causes penile erection (1,10,11). A normal rigid erection following intracorporal injection of papaverine can rule out vasculogenic impotence (1). However, the significance of a partial short-lived erection or no erection is still of uncertain significance. Failure to respond may be due to reduced arterial inflow, augmented venous outflow, a combination of both, or can be due to excessive adrenergic-constrictor tone as a result of anxiety (1,10-12).

Arterial insufficiency can be evaluated by penile blood pressure, Doppler pulse-wave analysis, duplex sonography and angiography. Corporal venous outflow can be evaluated by dynamic infusion cavernosometry and cavernosography (1). This is an invasive procedure with infusion of large amounts of saline that causes overdistention of the corpora, takes a long time to perform, may be painful, and causes patient discomfort.

Nuclear medicine techniques have been used in the evaluation of patients with erectile dysfunction (2-7). Radioisotope penile plethysmography uses intravenous injection of Tc-RBC and pharmacologically-induced tumescence. It measures intrapenile blood volume and has been shown to be useful in the evaluation of arterial inflow disorders (2,3), but does not correlate with venous leak (3). Nsyeo et al. (4) and Lin et al. (5) reported that measurement of penile xenon washout is an effective method to evaluate penile arterial insufficiency after injection of the radioactive gas into the subcutaneous prepuce. However, they could not evaluate venous leak since skin blood flow is not related to corporal outflow. Haden et al. (6) studied penile xenon washout after intracorporal injection of radioactive gas in the flaccid state. They found no significant difference in penile blood flow between the impotent patients studied and the normal group. However, they suggested that xenon washout measurements can be used to measure penile venous outflow with stimulated or induced erection.

Schwartz and Graham (7) used a combined radioisotope penile plethysmography and intracorporal xenon washout method following intracorporal injection of papaverine to induce tumescence. Their study shows that xenon outflow measurements alone could not be used to predict competence of the veno-occlusive mechanism. Xenon-133 washout is a multi-variable function dependent on more than one vascular process, and the washout curve has a slow component that may not be related to blood flow but rather to absorption in adipose tissue (13). The measurement of the clearance of an intravascular agent injected intracorporally may reflect venous blood outflow from the corpus cavernosum. In the present study, corporal venous outflow was evaluated using a radioisotope technique that utilizes intracorporal injection of Tc-RBC both in the flaccid state and after intracorporal injection of papaverine and regitine. In the flaccid state, a rapid clearance of the Tc-RBC was found both in patients with venous leak and normal venous outflow, a finding similar to Haden’s study (6) with intracorporal xenon washout. However, after intracorporal injection of papaverine, 12 of 13 patients with normal venous outflow showed a more horizontal curve with a steeper slope after the reinjection of the Tc-RBC (Fig. 1). None of the patients with venous leak has demonstrated this characteristic.

Quantitation of T50% provides a criterion for discriminating patients with venous leak from patients with normal venous outflow. The method seems to be of no use in the flaccid state, where the sensitivity was 52%, specificity 92% and accuracy 80% when using threshold of 75 sec. However, after papaverine injection and using a threshold of 500 sec, sensitivity was 100%, specificity 92%, and accuracy was 95% in separating venous leak from normal venous outflow. One patient in the present study had arterial insufficiency and this method showed the presence of a normal venous outflow. However, further work is needed to determine the role of this method in patients with arterial insufficiency. The method is rapid, easy to perform, and uses small amounts of injection that cause no overdistention of the corpora.

In conclusion, the results suggest that the measurement of the corporal clearance of intracorporally injected Tc-RBC after papaverine may be a useful method in detecting significant venous leak and could be used as a screening test in patients with erectile dysfunction.

REFERENCES
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