Is transrectal ultrasonography a reliable diagnostic approach in ejaculatory duct sub-obstruction?

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We studied the diagnostic predictive power of transrectal ultrasonography (TRUS) coupled with semen volume in cases of distal seminal tract sub-obstruction. As a gold standard for diagnosis we used seminal tract washout (STW). Non-azoospermic subjects (n = 112) were submitted to transrectal ultrasonography because of suspected excretory infertility or other andrological pathologies, before performing STW. STW indicated ejaculatory duct sub-obstruction in 36.6% of the patients. Seminal vesicle enlargement (anterior–posterior diameter $\geq$ 15 mm) and seminal vesicle roundish anechoic areas (stasis) were the ultrasonographic anomalies more often associated with ejaculatory duct sub-obstruction. Stepwise logistic regression (SLR) analysis revealed that the ultrasonographic evidence of stasis was highly diagnostic only in the presence of a low semen volume ($\leq$ 1.5 ml) and that ejaculatory duct sub-obstructions may be present but with no evidence of ultrasonographic anomalies. Therefore, TRUS is a useful approach for the treatment of suspected ejaculatory duct sub-obstruction, but is not a reliable diagnostic tool and, before performing transurethral surgery, STW should be mandatory.

Key words: male infertility/semen volume/seminal vesicle/ultrasonography

Introduction

Ejaculatory duct sub-obstructions are congenital or acquired disorders (Goldwasser et al., 1985; Pryor and Hendry, 1991) associated with one or both seminal ducts. They may coexist with only slightly altered seminal patterns or with secretory pathologies affecting the testis (Colpi et al., 1994a). Their evolutionary process has been observed in fertile normospermic patients who gradually become oligospermic and eventually azoospermic when the ejaculatory duct obstruction becomes complete (Pryor and Hendry, 1991). These pathologies are usually surgically diagnosed through vasovasoculography (VVG) (Boreau, 1974) and treated by transurethral surgery (Silber, 1980).

Recently, several authors have pointed out the usefulness of transrectal ultrasonography (TRUS) in diagnosing ejaculatory duct (sub-)obstruction and suggested VVG to be performed only in doubtful cases. Müllerian cysts, ejaculatory duct stones, hyperechoic areas involving veru montanum or the enlargement of seminal vesicles are considered ultrasonographic signs suggestive of incomplete distal obstruction, in particular when coexisting with palpable vasa, low semen volume and oligo-asthenozoospermia (Hellerstein et al., 1992; Meacham et al., 1993; Thompson et al., 1993; Wurisch and Parra, 1993). On the other hand, our group (Colpi et al., 1990, 1994a) has proposed seminal tract washout (STW) as a gold standard for distal seminal tract (sub-)obstruction diagnosis in conjunction with testicular biopsy, epididymal exploration and VVG. Indeed, SWT is a functional diagnostic technique that seems much more reliable than morphological investigations such as VVG and TRUS, and it has the advantage of allowing recruitment of spermatozoa for infertility programmes. Performed by the same surgical procedure as VVG, STW allows the spermatozoa contained in the vasa deferentia, deferential ampullae, seminal vesicles and ejaculatory ducts tract to be recovered from the bladder and their concentrations determined. The STW count can be compared with the total sperm count present in the ejaculate, performed under the same conditions of abstinence (EJA count), and in normal subjects STW count/EJA count is always $<1$ (Freund and Davis, 1969; Jouannet and David, 1978; Amann and Howards, 1980). Because any anatomical or functional alteration of the distal seminal tract leads to difficulties of voiding through the ejaculatory ducts, and consequent partial sperm retention inside the vasa deferentia and the ampullo–vesicular tracts, an inverse physiological ratio between STW count and EJA count is always observed and a STW count/EJA count $>1$ may be diagnostic of ejaculatory duct sub-obstruction (Colpi et al., 1994a). However, STW is a surgical approach and therefore should be performed only in certain selected cases. It is therefore necessary to devise alternative non-invasive diagnostic techniques, such as TRUS.

Therefore, by comparing retrospectively data obtained by STW with a non-invasive investigation such as TRUS, we aimed to assess whether or not TRUS may be considered a reliable method for diagnosis of the presence of a suspected ejaculatory duct sub-obstruction.

Materials and methods

Subjects

A total of 112 non-azoospermic men (age: mean 34.4, median 34, range 20–60 years) were subjected to STW because of suspected
corpora lutea, the testis of endocrine activity was excluded and the patients entered the procedure.

Each infertile patient underwent a preliminary TRUS, followed by both a testicular biopsy and an epididymal exploration. A seminal tract obstruction was suspected on the basis of at least two of the following factors: at least one normal-sized testis (Jarow et al., 1989), follicle stimulating hormone (FSH) less than twice the normal value (Jarow et al., 1989), low semen volume (Worrischeck and Parra, 1993), irregular or dilated epididymis (Littrup et al., 1988).

After STW, certain patients (n = 71) were submitted to VVG.

Infertility was secondary in three patients, while previous semen analyses had been normal in 17 subjects. Vas agenesis was excluded in all patients.

**Seminal tract washout (STW)**

STW was performed under either general or local anaesthesia. A standard 3–5 day period of sexual abstinence was required prior to undergoing the procedure. Every patient received a single dose of cefotaxime (1 g i.m.) to prevent subsequent bacterial infections.

After the exposure of the vas deferentia with the aid of an Allis forceps, the vasa were denuded of their tunica to an extent of ~1 cm. The proximal vascular loop was always kept taut to compress the epididymal tubule damage due to hyperpressure in the seminal tract, the proximal vascular loop was always kept taut to compress the deferential lumen near the cauda epididymis.

After the solution had been injected and had back passed into the bladder, it was recovered through a Foley catheter or, if the preliminary TRUS had shown no bladder residual urine after voiding, through the two first micturitions. The fluid recovered was composed of spermatzoa washed out of the deferential ampullary and seminal vesicle pool, together with urine, methylene blue, saline solution and, when no bladder catheterization was performed, contrast medium. After centrifugation at 4000 Rpm for 10 min, the pellet recovered was diluted and the retrieved spermatzoa were counted (STW Count) and compared with the highest total sperm count (EJA count) obtained under the same abstinence conditions.

An STW count/EJA count proportion >1 was considered to be a reliable diagnostic criterion of the presence of ejaculatory duct sub-obstruction (Colpi et al., 1994a).

The total time required for STW was ~15 min and the procedure was as safe as that of puncture vasovesiculography (Poore et al., 1996). Three months after STW, all patients underwent at least one semen analysis. None had a reduced total sperm count, showing that no epididymal or vas obstructions had arisen secondary to STW.

**Semen analysis**

All patients underwent at least two semen analyses according to World Health Organization (WHO) criteria (1987). Patients had been previously requested to perform a milking of the urethra at the end of their ejaculation with the penis back to a flaccid condition, to achieve a more complete semen recovery. The highest values obtained for the semen volume were used for this study.

Post-ejaculatory urinalysis excluded the presence of partial retrograde ejaculation in all patients.

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**Table I. Classification of TRUS anomalies**

<table>
<thead>
<tr>
<th>Classification</th>
<th>No. of observations</th>
</tr>
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<tbody>
<tr>
<td>Median intraprostatic cyst (Müllerian cyst) (diameter &gt;5 mm)</td>
<td>26</td>
</tr>
<tr>
<td>Enlarged seminal vesicle (anterior–posterior diameter ≥15 mm)</td>
<td>29</td>
</tr>
<tr>
<td>Seminal vesicle stasis*</td>
<td>57</td>
</tr>
<tr>
<td>Ejaculatory duct anomaliesb</td>
<td>15</td>
</tr>
</tbody>
</table>

*Images of anechoic polycystic areas due to the fluid retention inside seminal vesicles.

bEnlarged and anechoic ejaculatory duct, seminal concretions inside the ejaculatory duct, or veru montanum calcification.

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**Figure 1.** Transrectal ultrasonography (transversal scan on the left, longitudinal scan on the right). Median intraprostatic cyst (Müllerian cyst) marked by calipers.

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**Transrectal ultrasonography**

Two different ultrasonographic consoles (Esaote 590A and Esaote AU4 Idea, Esaote Biomedica, Italy) were used with 6.5–7.5 MHz transrectal biplanar probes. For the purpose of excluding variations induced by sexual abstinence, TRUS was regularly performed no more than 2 h after the ejaculation used for semen analysis.

The investigation was always carried out by the same andrologist (L.N.) and one copy of the photographic documentation was retained in our file. No areas suggestive of prostatic cancer or benign prostatic hyperplasia were found.

A seminal vesicle displaying an antero–posterior diameter ≥15 mm was considered to be suggestive of glandular dilatation (Littrup et al., 1988; Carter et al., 1989; Meucham et al., 1993). The classification of the TRUS anomalies observed is reported in Table I and three examples are shown in Figures 1, 2 and 3. ‘Seminal vesicle stasis’ is defined as the presence in TRUS images of anechoic roundish areas, often in a honeycomb pattern, due to the fluid retention inside seminal vesicles (Figure 2). Ejaculatory duct anomalies are defined as the presence of an enlarged and anechoic ejaculatory duct (Figure 3), of seminal concretions inside the ejaculatory duct, or of veru montanum calcification.

**Statistical analysis**

**Descriptive analysis**

Continuous variables are presented as mean ± SE, while categorical variables are presented as frequency tables.

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Transrectal ultrasonography (longitudinal scan): seminal vesicle with multiple roundish anechoic areas (arrows) due to sperm retention (= stasis).

Figure 3. Transrectal ultrasonography (longitudinal scan): enlarged and anechoic ejaculatory duct.

**Inferential analysis**

The variables recorded by TRUS are indicated as:

- Seminal vesicle stasis: yes–no.
- Anterior–posterior diameter of the larger seminal vesicle in mm.
- Mullerian cysts: yes–no.
- Ultrasonographic anomalies of ejaculatory duct: yes–no.
- Semen volume, measured in ml.

These were analysed by stepwise logistic regression (SLR) analysis (BMDP Statistical Software Inc., Los Angeles, CA, USA) as independent variables to calculate the probability of observing ejaculatory duct sub-obstruction (STW count/EJA count proportion >1).

Non-parametric Mann–Whitney U-test and Yates’ corrected $\chi^2$ were used to compare any single TRUS variable and semen volume in the group of patients with sub-obstruction versus the one without obstruction.

**Results**

**STW and semen analysis**

An ejaculatory duct sub-obstruction (STW count/EJA count proportion >1) was found in 36.6% of infertile patients and was associated with a mean semen volume of 1.6 ml. The mean semen volume was 3.5 ml in the absence of ejaculatory duct sub-obstruction ($P < 0.01$). Total sperm counts were 25.2$\times 10^6$ (median 8.0$\times 10^6$) and 26.8$\times 10^6$ (median 5.4$\times 10^6$) (n.s.) respectively (Table II).

Parameters recorded by TRUS were analysed according to the results obtained by STW and are summarized in Table III. A significant increase in the mean seminal vesicle anterior–posterior diameter was found in subjects with ejaculatory duct sub-obstruction ($P < 0.01$). The majority of such patients (85%) displayed anechoic areas (stasis) inside the seminal vesicles, while this echographic finding was present in only 31% of the subjects with no distal sub-obstruction (Yates’ corrected $\chi^2 P < 0.01$). Therefore, when comparing the two groups, the relative risk of finding seminal vesicle stasis when a patient suffered from ejaculatory duct sub-obstruction (STW count/EJA count proportion >1) was 2.8 times higher, with a 95% confidence interval ranging between 1.9 and 4. In addition, a Mullerian cyst was present in 37 and 14% of the subjects with and without ejaculatory duct sub-obstruction (Yates’ corrected $\chi^2 P < 0.02$). The relative risk of finding a Mullerian cyst was 2.4 times higher in patients with obstruction, with a 95% confidence interval ranging between 1.2 and 4.6. No significant differences between the two groups were found in the percentage of subjects with mono- or bilateral ejaculatory duct anomaly.

**Stepwise logistic regression (SLR) analysis**

A regression logistic model was applied to the parameters found by TRUS and to the mean semen volume. This demonstrated that the parameters with the best predictive power were the seminal vesicle stasis, the anterior–posterior diameter of the larger seminal vesicle and the semen volume, while Mullerian cyst or ejaculatory duct ultrasonographic anomaly was not significant, since they added no further precision to the calculation of sub-obstruction probability (the presence of...
Müllerian cyst was highly correlated with parameters which define the model, while ejaculatory duct ultrasonographic anomalies showed a low predictive capacity.

Table IV reports the results of SRL analysis using the logistic model equation:

\[
P = \frac{e^u}{1 + e^u}
\]

where \(P\), the dependent variable coded as 0 (without ejaculatory duct sub-obstruction) or 1 (with ejaculatory duct sub-obstruction), is the predicted proportion of positive response (ejaculatory duct sub-obstruction), and \(u\) is a linear function of one or more independent variables. In our logistic model \(u\) is defined by the equation:

\[
u = 2.248 + 0.9602 \times \text{semen volume} - 1.865 \times \text{stasis} - 0.232 \times \text{seminal vesicle diameter}
\]

The independent variables, i.e. semen volume and seminal vesicle diameter, must be considered continuous, while seminal vesicle stasis is categorically coded as 0 when it is absent or 1 when it is present.

Therefore, applying the above equation, it was possible to calculate the probability of finding a sub-obstruction of the ejaculatory ducts (STW count/EJA count proportion \(>1\)) from pre-determined semen volume, seminal vesicle diameter and stasis conditions. Figure 4 shows the percentage of probability that an ejaculatory duct sub-obstruction may be present (100 – \(P\times100\)).

To clarify this concept, we report a clinical speculation. A patient presents with a mean semen volume of 1.5 ml and a seminal vesicle diameter =1.5 mm without stasis. According to our model, the probability of finding a sub-obstruction is 45%. On the other hand, if the same patient has a mean semen volume of 2 ml, the probability is 33%. However, if he also displays stasis inside the seminal vesicles, the probability of finding a sub-obstruction rises to 84 and 76% respectively.

Discussion

This study demonstrates that parameters recorded by TRUS, such as seminal vesicle enlargement (anterior–posterior diameter \(\geq 15\) mm) and seminal vesicle roundish anechoic areas (stasis) were the ultrasonographic anomalies more often associated with ejaculatory duct sub-obstructions diagnosed by STW. In addition, ultrasonographic evidence of stasis was highly diagnostic only in the presence of low semen volume. However, ejaculatory duct sub-obstructions diagnosed by STW might also be present with no evidence of ultrasonographic anomalies, suggesting that TRUS should not be considered to be a completely reliable diagnostic tool.

Complete ejaculatory duct obstruction usually does not give rise to diagnostic difficulties, given the presence of very special seminal and ultrasonographic alterations (Carter et al., 1989; Worischeck and Parra, 1993). Conversely, the picture regarding oligo- or asthenozoospermia due to distal incomplete obstructions is considerably more complex. Indeed, although it has been confirmed that a low semen volume and certain specific alterations of the ultrasonographic anatomy of the distal seminal tract may be correlated with sub-obstructive dysfunctions, such dysfunctions may be present also in the absence of clear seminal (Hellerstein et al., 1992; Thompson et al., 1993) or ultrasonographic (Jarow, 1993) alteration. Under these circumstances, vasography (Pryor and Hendry, 1991; Weintraub et al., 1993) is usually performed, although some investigators have disputed its diagnostic reliability (Belker and Steinbock, 1990).

Ejaculatory duct sub-obstruction is increasingly diagnosed by correlation of the classical seminal parameters with TRUS outcome (Goldwasser et al., 1985; Belker and Steinbock, 1990; Hellerstein et al., 1992; Meacham et al., 1993; Thompson et al., 1993; Worischeck and Parra, 1993) because of the
limited invasiveness and low cost of this investigation. TRUS is generally performed when the semen volume is <1.5 ml (Meacham et al., 1993), since a low semen volume is considered to be the only parameter which may indicate an anomaly at TRUS (Jarow, 1993). That notwithstanding, our results demonstrated a high percentage of patients suffering from distal sub-obstruction (36.5%) in the presence of mean semen volume ≥1.5 ml (range 1.8–7 ml). This suggests that TRUS should be performed in all infertile patients when diagnostic, clinical or seminological features are likely to imply the existence of a sub-obstruction, regardless of the mean semen volume. Indeed, whereas it is certainly true that ejaculatory duct sub-obstruction is associated with a reduction in the ejaculated semen volume, it is also evident that the final degree of reduction depends on the initial semen volume. Some of our infertile patients with sub-obstruction and a semen volume >1.5 ml had, during previous semen analyses, displayed a semen volume twice or three times greater than that obtained during the investigation.

Some investigators (Littrup et al., 1988; Carter et al., 1989; Meacham et al., 1993) have observed that the enlargement of at least one seminal vesicle (diameter ≥15 mm) is predictive of ejaculatory duct sub-obstruction. Our data showed that in 75% of cases, seminal vesicle enlargement was associated with a distal seminal tract sub-obstruction. All those patients who had an anterior–posterior diameter ≥15 mm and a semen volume ≤1.5 ml were diagnosed as having ejaculatory duct sub-obstruction. However, a dysfunction could not be excluded when the seminal vesicles diameter was smaller. Indeed, STW confirmed insufficient emptying of the distal seminal tract in 43.9% of patients, even when the seminal vesicles diameter was bilaterally <15 mm and was <10 mm in six of these subjects. The possibility that a sub-obstruction of the ejaculatory ducts may coexist with normal-sized vesicular diameters has been confirmed by Jarow (1993) in one patient with veru iperechoic areas.

As far as ultrasonographic evidence of roundish anechoic areas (stasis) within seminal vesicles was concerned, the risk of ejaculatory duct sub-obstruction in patients with seminal vesicle stasis was 2.8 times higher than in the patients with normally echoic seminal vesicles (CI 95%: 1.9 ± 4.0). While some ultrasonographic anomalies of ejaculatory ducts (i.e., Müllerian cysts, seminal concretions inside the ejaculatory ducts, etc.) are commonly associated with the presence of ejaculatory duct partial or complete obstruction, few investigators (Colpi et al., 1990; Meacham et al., 1993) have considered the presence of roundish anechoic areas (stasis) to be parameters predictive of sub-obstruction. Christiansen et al. (1991) described roundish anechoic areas in subjects suffering from chronic abacterial prostatovesiculitis. However, all our patients were asymptomatic and none had severe leukospermia or a high leukocyte concentration in the seminal washing. Moreover, we confirmed that Müllerian cysts may be considered diagnostic of a sub-obstruction, with a relative risk 2.4 times higher (CI 95%: 1.2 ± 4.6), while the presence of an ultrasonographic anomaly of ejaculatory ducts (i.e., dilatations, veru montanum calcifications, seminal concretions) was, on its own, scarcely predictive.

Collectively, multivariate logistic analysis comparing STW diagnoses with semen volume and TRUS parameters strongly suggested that, even though the latter may be helpful in diagnosing or excluding an ejaculatory duct obstruction, they are still insufficient, in some circumstances, for the reliable diagnosis of a sub-obstruction. An indirect confirmation of this comes from a controversy concerning the use of transurethral resection or incision of the ducts (TURED) (Goldwasser et al., 1985; Belker and Steinbock, 1990; Hellerstein et al., 1992; Meacham et al., 1993; Thompson et al., 1993; Worischeck and Parra, 1993; Turek et al., 1996). Indeed, when TURED was performed following a TRUS diagnosis of ejaculatory duct sub-obstruction, sperm count or motility cumulatively improved in ~50% of cases, while only in ~30% of cases did the semen volume also improve. Thus, it should be concluded that in 50% of these patients, the ultrasonographic or seminal alterations which had been considered sufficient to justify a surgical approach did not correspond to a genuine (sub-)obstruction of ejaculatory ducts.

Finally, it is important to mention that vasography is also not infallible in diagnosing ejaculatory duct partial obstruction, since we observed several discrepancies between VVG results and STW counts (data not shown) in our patients. Even though this observation seems to confirm that a normal ejaculatory emptying of the ampullo-vesicular tract may coexist with anatomically altered ejaculatory ducts, it indicates the possibility that a distal voiding disorder may exist in the presence of anatomically normal ejaculatory ducts.

This type of dysfunction, called ‘functional emptying disorder of the distal seminal tract’ (Colpi et al., 1987), has been previously described (Ichijo et al., 1981; Tiffany and Goldstein, 1985; Pryor and Hendry, 1991) and it may be attributable to a hidden local neuropathy. Because of the vasographic patterns of ampullo-vesicular atony or of ejaculatory duct hypertony, this abnormality may be related to dysfunctions affecting the urinary apparatus (bladder detrusor–sphincter dyssynergia).

On the basis of the present results, we propose STW as the gold standard for distal seminal tract sub-obstruction diagnoses. It is only through the retrieval of a high number of spermatozoa downstream from the epididymis that it is possible to confirm: (i) the existence of an emptying disorder of the distal seminal tract and (ii) transition through the epididymis. In addition, STW enables the recruitment, with appropriate media and bladder preparation, of a high number of spermatozoa for conventional assisted reproductive technology or micromanipulation (Colpi et al., 1994b).

We can conclude that TRUS is a useful approach for the diagnosis of ejaculatory duct sub-obstruction but that this dysfunction may also be present with no evidence of ultrasonographic abnormalities. Therefore, other techniques, such as STW, should be mandatory.

References
Male tract diagnosis by transrectal ultrasonography


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