ABSTRACT

**Background:** Pelvic ultrasound is generally performed in two parts, transabdominal ultrasound and transvaginal ultrasound. In order to obtain the best images and the greatest chance at a diagnosis, the consensus appears to be that patients must have a full bladder prior to undergoing pelvic ultrasound. A commonly used operational definition of a full bladder is 250 to 300 cc. Patients can be given fluids by mouth, or intravenously (as an IV bolus). Both approaches can be used. Some scenarios (nausea, pre-operative status, etc) may favor one approach over another. It is also possible to fill the bladder with a Foley catheter which remains in place for the duration of the study. **Materials and Methods/Research Design and Methods:** The purpose of this study was to determine which of the current non-Foley catheter-based methods of bladder-filling (IV bolus, oral fluid intake, or a combination of both) most rapidly produces an adequately filled (> 250 cc) bladder volume for pelvic ultrasound. The setting was three community hospital/university-affiliated emergency departments.

The design was prospective with subjects randomly assigned to one of three treatment groups: 1) 1,000 cc normal saline bolus administered IV over 1 hour; 2) Oral ingestion of 32 ounces water (with ice in cup) with or without added flavoring (e.g. Crystal Light) per patient preference 3) Bladder to be filled through combination of the above methods performed simultaneously (i.e. 1L NS IVF bolus and 32 oz. water). **Results:** The fastest filling was with the oral route. The slowest was with the IV route. The difference in filling (in the direction of faster filling) was highly statistically significant in reference to the oral vs. the IV route.
transvaginal ultrasound has limited range and may not be
frequently better visualization, of the pelvic organs. However,
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transvaginal approach does not require a full bladder
posterior pelvic organs (i.e. the uterus and ovaries). The
aid transmission of the ultrasound signal to the more
this helps to clear bowel and bowel gas from the field and
if the patient has what is referred to as a "full bladder" as
The transabdominal ultrasound is generally more successful
EDs, is the imaging modality of choice for these patients.
gynecology [1,2]. Ultrasound, now readily available in most
limited utility. As technology has improved, ultrasound has
become a routinely used and vital tool within the practice
of medicine. One area in which ultrasound has assumed a
particularly important role is in the field of obstetrics and
gynecology [1,2]. Ultrasound, now readily available in most
EDs, is the imaging modality of choice for these patients.
Pelvic ultrasound is generally performed in two parts,
transabdominal ultrasound and transvaginal ultrasound.
The transabdominal ultrasound is generally more successful
if the patient has what is referred to as a “full bladder” as
this helps to clear bowel and bowel gas from the field and
aid transmission of the ultrasound signal to the more
posterior pelvic organs (i.e. the uterus and ovaries). The
transvaginal approach does not require a full bladder
and has the advantage of closer proximity, and therefore
frequently better visualization of the pelvic organs. However,
transvaginal ultrasound has limited range and may not be
able to visualize pathology associated with those areas of
the uterus or pelvis most distal to the probe. Therefore, most
radiologists prefer that both approaches be included for a full
evaluation of the pelvic organs. Furthermore, not all patients
will tolerate or agree to transvaginal imaging, leaving
transabdominal ultrasound as the only option in some cases.
In order to obtain the best images and the greatest chance at
a diagnosis, the consensus appears to be that patients must
have a full bladder prior to undergoing pelvic ultrasound [3].
The literature shows that there has been some intermittent
challenge to this premise, but it appears that a full bladder
protocol for an optimal study is the general practice currently
[4].

A very important issue then is the operational definition of
a full bladder. A commonly used operational definition of
a full bladder is 250 to 300 cc. It is intuitively obvious that
there are several possible approaches to bladder filling.
Patients can be given fluids by mouth, or intravenously (as
an IV bolus). Both approaches can be used. Some scenarios
(nausea, pre-operative status, etc.) may favor one approach
over another. It is also possible to fill the bladder with a Foley
catheter which remains in place for the duration of the study.
Which of the three standard non-Foley-catheter-based
methods is best? A review of the literature (PubMed) does
not appear to return an answer to this rather practical
question. The purpose of this study is to determine which
of the current non-Foley used methods of bladder-filling
(IV bolus, oral fluid intake, or a combination of both) most
rapidly produces an adequately filled bladder for pelvic
ultrasound.

**MATERIALS AND METHODS**

The purpose of this study was to determine which of the
current non-Foley catheter-based methods of bladder-filling
(IV bolus, oral fluid intake, or a combination of both) most
rapidly produces an adequately filled (> 250 cc) bladder volume for pelvic ultrasound. The setting was
three community hospital/university-affiliated emergency
departments.

The design was prospective with subjects randomly assigned
to one of three treatment groups: 1) 1,000 cc normal saline
bolus administered IV over 1 hour, 2) Oral ingestion of 32
ounces water (with ice in cup) with or without added flavoring
(e.g. Crystal Light) per patient preference 3) Bladder to be
filled through combination of the above methods performed
simultaneously (i.e. 1L NS IVF bolus and 32 oz. water). The
study was IRB approved and written consent was obtained

(p=0.001) There was no statistical significance in reference
to the comparison of the combined route (IV/PO) vs oral or
IV, and hence no advantage seen for the combined routes
in reference to filling speed. The greatest change in volume
was seen with the oral route and the slowest was with the
IV route. The oral route showed a statistically significant
difference, in the direction of a larger filling delta, with oral
route in comparison to both the IV route (p=0.001) as well
as in comparison to the combined (IV/PO) route (p=0.03).
There was no statistically significant difference noted in
comparison of the various routes in reference to time to US.
**Discussion:** The fastest filling was with the oral route. The
slowest was with the IV route. There was no statistically
significant difference noted in comparison of the various
routes in reference to time to ultrasound. Time to ultrasound
is affected by system properties that are more complex than
time to filling. **Conclusions:** The fastest filling was with the
oral route. The slowest was with the IV route. There was
no statistically significant difference noted in comparison
of the various routes in reference to time to ultrasound.
Time to ultrasound is affected by system properties that are
more complex than time to filling. Future research might
show the advantage of optimizing ultrasound cycle time by
coordinating ultrasound acquisition in the ED setting with a
full bladder.

**Keywords:** Pelvic ultrasound; Bladder filling method;
Bladder volume; Transabdominal ultrasound

**INTRODUCTION**

Ultrasound first emerged as a diagnostic imaging tool in the
1950’s, although its earliest form was so crude as to have
limited utility. As technology has improved, ultrasound has
become a routinely used and vital tool within the practice
of medicine. One area in which ultrasound has assumed a
particularly important role is in the field of obstetrics and
gynecology [1,2]. Ultrasound, now readily available in most
EDs, is the imaging modality of choice for these patients.
Pelvic ultrasound is generally performed in two parts,
transabdominal ultrasound and transvaginal ultrasound.
The transabdominal ultrasound is generally more successful
if the patient has what is referred to as a “full bladder” as
this helps to clear bowel and bowel gas from the field and
aid transmission of the ultrasound signal to the more
posterior pelvic organs (i.e. the uterus and ovaries). The
transvaginal approach does not require a full bladder
and has the advantage of closer proximity, and therefore
frequently better visualization of the pelvic organs. However,
transvaginal ultrasound has limited range and may not be
from all participants.

Prior to beginning any filling method, the patient had a bladder scan to assess initial bladder volume. Patients with a starting volume >200 cc were excluded.

The patients then had additional bladder scans at 20 minute intervals, with additional scans for patient's self-reported sensation of fullness, until a volume >250 cc is achieved.

The sample size was 10 subjects minimum in each of the three groups, for a total 30 subjects minimum. Inclusion criteria included female patient between the ages of 18 and 65 year old, who were hemodynamically stable and, in the ordinary course of their treatment, would require a pelvic ultrasound for evaluation of complaints of vaginal bleeding, vaginal bleeding in pregnancy, lower abdominal pain, or pelvic pain. Patients will be excluded who are less than 18 years old, greater than 65 years old, or are hemodynamically unstable. Also, patients will be excluded who have an initial bladder volume >200 cc as well as patients with vomiting not adequately controlled with medication.

**STATISTICAL ANALYSIS**

Groups will be compared using Student’s T test.

**RESULTS**

The results for filling rates in cc/min are noted below (Tables 1, 2 and Figure 1).

The fastest filling was with the oral route. The slowest filling was with the IV route. The difference in filling (in the direction of faster filling) was highly statistically significant in reference to the oral vs. the IV route. (p=0.001) There was no statistical significance in reference to the comparison of the combined route (IV/PO) vs oral or IV, and hence no advantage seen for the combined routes in reference to filling speed.

The results for total change in volume in cc/min are noted below (Tables 3, 4, and Figure 2). The greatest change was seen with the oral route and the slowest was with the IV route. The oral route was showed a statistically significant difference, in the direction of a larger filling delta, with oral route in comparison to both the IV route (p=0.001) as well as in comparison to the combined PO/IV route (p=0.03)

The times to ultrasound for each route are summarized below (Tables 5,6 and Figure 3). There was no statistically significant difference noted in comparison of the various routes in reference to time to US.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Route_3</th>
<th>Mean</th>
<th>StDev</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>cc/min</td>
<td>IV</td>
<td>3.058</td>
<td>1.431</td>
<td>3.050</td>
</tr>
<tr>
<td></td>
<td>oral</td>
<td>5.850</td>
<td>2.046</td>
<td>5.595</td>
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<tr>
<td></td>
<td>oral and IV</td>
<td>4.89</td>
<td>3.47</td>
<td>3.79</td>
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<table>
<thead>
<tr>
<th>cc/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral vs IV</td>
</tr>
<tr>
<td>Oral vs PO/IV combined</td>
</tr>
<tr>
<td>IV vs PO/IV combined</td>
</tr>
</tbody>
</table>
Descriptive Statistics: delta volume

Statistics

Table 3

<table>
<thead>
<tr>
<th>Variable</th>
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<th>StDev</th>
<th>Median</th>
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</thead>
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<tr>
<td>delta volume</td>
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<td>176.7</td>
<td>78.0</td>
<td>173.0</td>
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<tr>
<td></td>
<td>oral</td>
<td>352.9</td>
<td>124.6</td>
<td>389.5</td>
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<tr>
<td></td>
<td>oral and IV</td>
<td>242.5</td>
<td>109.4</td>
<td>228.0</td>
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Table 4

<table>
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<th>delta filling</th>
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<tbody>
<tr>
<td>Oral vs IV</td>
<td>0.001</td>
</tr>
<tr>
<td>Oral vs PO/IV combined</td>
<td>0.03</td>
</tr>
<tr>
<td>IV vs PO/IV combined</td>
<td>NS</td>
</tr>
</tbody>
</table>

Figure 1

![Interval Plot of Oral cc/min, IV cc/min_1, Oral/IV cc/min_2 95% CI for the Mean](image)

Figure 2

![Interval Plot of Delta Volume, Oral, IV, oral and IV 95% CI for the Mean](image)
DISCUSSION

The fastest filling was with the oral route. The slowest was with the IV route. The difference in filling (in the direction of faster filling) was highly statistically significant in reference to the oral vs. the IV route. (p=0.001) There was no statistical significance in reference to the comparison of the combined route (IV/PO) vs oral or IV, and hence no advantage seen for the combined routes in reference to filling speed.

This is supported by data concerning the total change in amount (in cc) by route. The greatest change was seen with the oral route and the slowest was with the IV route. (Table below). The oral route was showed a statistically significant difference, in the direction of a larger filling delta with the oral route in comparison to both the IV route (p=0.001) as well as in comparison to the combined PO/IV route (p=0.03).

The ultrasound bladder scan approach to determining bladder volume has been shown to be accurate [5,6]. No comparable studies are available for comparison.

CONCLUSIONS

The fastest filling was with the oral route. The slowest filling was with the IV route. The difference in filling (in the direction of faster filling) was highly statistically significant in reference to the oral vs. the IV route. (p=0.001) There was...
no statistical significance in reference to the comparison of the combined route (IV/PO) vs oral or IV, and hence no advantage seen for the combined routes in reference to filling speed. This is supported by data concerning the total change in amount (in cc) by route. The greatest change was seen with the oral route and the slowest was with the IV route. (Table below). The oral route was showed a statistically significant difference, in the direction of a larger filling delta, with oral route in comparison to both the IV route (p=0.001) as well as in comparison to the combined PO/IV route (p=0.03) The data suggest that the oral filling route if preferable when clinically possible and that there is no advantage to the combined IV/PO route.

REFERENCES


