Chapter 18
Water Deprivation Test

Indication:

1. To confirm diagnosis of diabetes insipidus (DI).
2. To differentiate between central DI, nephrogenic DI, and primary polydipsia.

Patient Preparation: Initiation of the deprivation period depends on the severity of the DI; in routine cases, the patient may be made NPO after dinner or midnight. If polyuria is severe, start NPO early in the morning of the test (e.g., 6 am) [1]. Desmopressin must be stopped for at least 24 h prior to the test. Patients should also avoid alcohol, tobacco, and caffeine starting from the night prior to the test.

Materials Needed:

Sodium:
gold top tube

Osmolality:
gold top tube

1. Labels and requisitions *all marked **STAT***.
2. Several serum separator tubes (SST) for sodium, labeled baseline and hourly.
3. Several SSTs for osmolality, labeled baseline and hourly.
4. Several urine cups for osmolality, labeled baseline and hourly.
5. Several plasma tubes for AVP.
6. DDAVP 2 mcg.
7. 500 cc 3 % saline, IV infusion set.
8. Heplock/syringes/needles.

Precautions: Severe dehydration (hypotension, tachycardia) may occur in patients with true diabetes insipidus. Weight loss should not be allowed to exceed 5 % of initial body weight and blood pressure should be monitored closely. Do not perform the water deprivation test in patients with renal insufficiency, uncontrolled diabetes mellitus, hypovolemia of any cause, untreated adrenal insufficiency, and hypothyroidism.

A. B. Ergin et al., *The Cleveland Clinic Manual of Dynamic Endocrine Testing,*
DOI 10.1007/978-3-319-13048-4_18

Interpretation: Normal response: Urine osmolality > 600 mOsm/kg.

1. If serum osmolality goes above 300 mOsm/kg or serum sodium goes above (upper limit of normal) ULN while urine osmolality is less than 300 mOsm/kg **primary polydipsia, partial neurogenic**, and **partial nephrogenic** DI ***are excluded***, and a challenge test with dDAVP 2 mcg SC is required.
   - DDAVP response, 2 h after DDAVP administration: higher than 50 % increase in urine osmolality indicates **central DI (CDI)** and less than 10 % increase strongly suggests **complete nephrogenic DI (NDI)** [1, 2].
2. If urine osmolality rises above 300 mOsm/kg before serum sodium is above the upper limit of normal; **complete neurogenic** and **complete nephrogenic DI are excluded**. Start 3 % saline infusion or extend the test if 3 % saline infusion is not possible. Once serum sodium or osmolality goal is achieved, draw blood for plasma AVP level and serum osmolality, and then administer DDAVP to see the response to DDAVP. See Figs. 18.1 and 18.2.

Caveats:

1. *In most patients, differentiation between different etiologies of DI may be reached by careful review of medical history and prior work up without a need for performing water deprivation test.*
2. If basal serum sodium concentration is above normal while the urine osmolality is below 300 mOsm/kg H2O, this test is unnecessary and can be potentially harmful. In this case, skip to the dDAVP challenge test.
3. Observation of the patient for the entire duration of the test is needed to prevent surreptitious drinking and non-osmotic stimulants of AVP secretion such as smoking, postural hypotension, vaso-vagal reactions, nausea, and hypotension.
4. If an episode of hypotension or nausea occurs, the entire test may be invalid, and it may need to be repeated on another day.
5. Complete emptying of the bladder during each collection should be ensured because the residual volume left in the bladder may dilute the urine of the next collection, and affect test interpretation. If incomplete emptying is suspected, creatinine concentration should be measured on each urine sample. Urine creatinine concentration multiplied by the urine volume should be quite constant.
6. Plasma AVP should be measured from heparinized blood. Plasma levels from samples processed with EDTA should not be used because they may contain variable artifacts that raise osmolality.
7. The osmometer for measurement of serum osmolality needs to be calibrated frequently against standard solutions. However, most hospital laboratories are unable to provide this degree of precision. Therefore it is better to rely on measurements of serum sodium concentration, which are determined with sufficient accuracy by most routine hospital laboratories

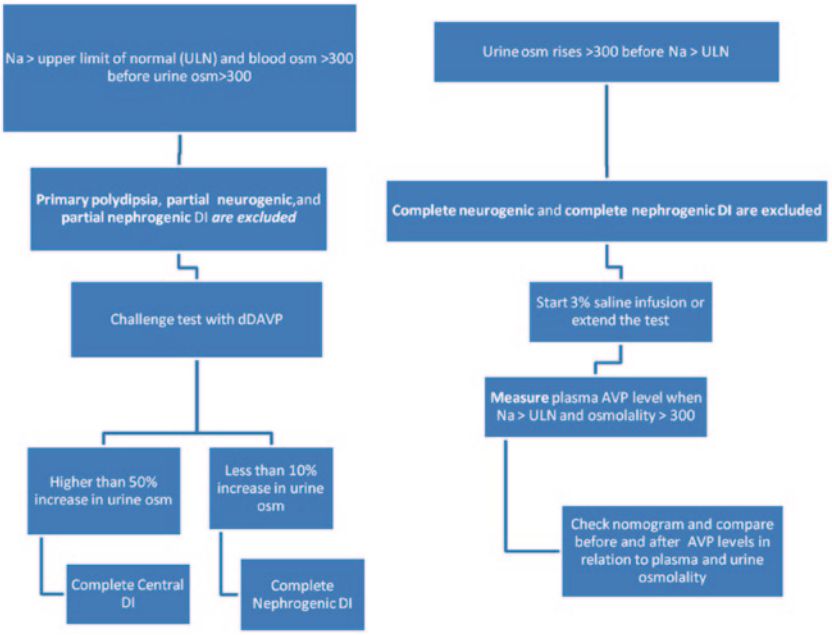

Fig. 18.1 Diagnostic algorithm for diabetes insipidus during water deprivation test

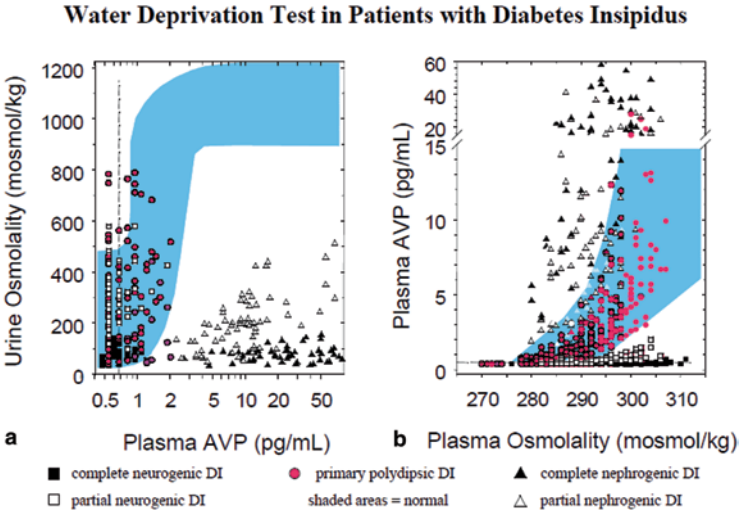

Fig. 18.2 Results of the water deprivation test on normal subjects (*shaded areas*) and patients with the three major forms of diabetes insipidus. Each plotted symbol represents a simultaneous sampling for two variables: plasma AVP (the antidiuretic hormone, arginine vasopressin) and urine osmolality (Fig. 18.1a), and plasma osmolality and plasma AVP (Fig. 18.1b). The *interrupted lines* denote the limit of the assay for plasma AVP; below the limiting value, no AVP can be detected in the plasma. (The data come from patients seen by Dr. Gary L. Robertson) [3]

Water Deprivation Test Procedure Start the test early in the morning. Observe the patient during the ENTIRE test. Do NOT leave the room unattended.

1. Record body weight and blood pressure after patient empties the bladder.
2. Calculate and document 95% of this weight on the patient's chart.
3. At baseline,
   a. Draw basic metabolic panel.
   b. Draw blood sample for STAT serum osmolality and sodium.
   c. Freeze 2 ml of plasma for later assay of AVP.
4. Every 1 h:
   a. Record urine volume.
   b. Check urine osmolality STAT
5. Every 2 h:
   a. Record body weight and blood pressure.
   b. Check serum sodium and osmolality STAT.
   c. Freeze 2 ml of plasma for later assay of AVP.
6. Stop the test when:
   - The serum sodium is > ULN or
   - Body weight decreases by 5% or
   - The patient develops hypotension, SBP > 100.
7. Obtain a plasma AVP level at the end of the test when serum sodium is > ULN.
8. Administer dDAVP (2 μg) sc and continue following urine osmolality and volume every 30 min for an additional 2 h. At this point, the test is completed.

If the serum sodium stays < ULN or the serum osmolality is < 300 mOsm/kg H2O when the urine osmolality is > 300, then consider infusion of hypertonic saline (3% NaCl at a rate of 0.1 ml/kg/min for 1–2 h) to reach these endpoints. Measure serum sodium STAT every 30 min until Na+ is above ULN. Measure plasma AVP in the same samples.

Patient label: _____

Orders:

Ordering Provider's Signature: _____ Date: _____

Time	BP	Weight	Urine volume	Urine osmolality	Serum sodium	Serum osmolality	Plasma AVP basal	Plasma AVP post
Baseline								

95% of initial body weight = _____

References

1. Verbalis JG. Management of disorders of water metabolism in patients with pituitary tumors. Pituitary. 2002;5(2):119–32.
2. Zerbe RL, Robertson GL. A comparison of plasma vasopressin measurements with a standard indirect test in the differential diagnosis of polyuria. N Engl J Med. 1981;305(26):1539–46.
3. Robertson GL, Valtin H. Water deprivation protocol. www.nccpeds.com/kidney/articles/water_deprivation_protocol_pdf (Approved by the Scientific Advisory Committee of the Diabetes Insipidus Foundation, Inc.).