UROLOGY IN PREGNANCY

edited by SELWYN Z. FREED, M.D.
NORMAN HERZIG, M.D.

UROLOGY IN PREGNANCY

edited by
Selwyn Z. Freed, M.D.
Professor and Chairman, Department of Urology
Albert Einstein College of Medicine
Montefiore Hospital and Medical Center
Bronx, New York

Norman Herzig, M.D.
Acting Head, Department of Obstetrics & Gynecology
Montefiore Hospital
Bronx, New York

WILLIAMS & WILKINS
Baltimore/London

Copyright © 1982
Williams & Wilkins
428 E. Preston Street
Baltimore, MD 21202, U.S.A.

All rights reserved. This book is protected by copyright. No part of this book may be reproduced in any form or by any means, including photocopying, or utilized by any information storage and retrieval system without written permission from the copyright owner.

Made in the United States of America

Library of Congress Cataloging in Publication Data

Main entry under title:

Urology in pregnancy.

Includes index.
1. Urinary organs—Diseases. 2. Pregnancy, Complications of. I. Freed, Selwyn Z. II. Herzig, Norman. [DNLM: 1. Pregnancy complications. 2. Urologic diseases—In pregnancy. WQ 260 u78]
RG577.u76 618.3 81-7595
ISBN 0-683-03351-4 AACR2

Composed and printed at the
Waverly Press, Inc.
Mt. Royal and Guilford Aves.
Baltimore, MD 21202, U.S.A.

Preface

The intimate embryologic and anatomic relationship of the genital and urinary tracts has led quite logically, in males, to the specialty of urology. Yet a similar association in females has nevertheless resulted in separate disciplines. Anatomic propinquity and overlapping disorders have led both gynecologists and urologists to monitor the birth of a subspecialty called gynecologic urology. A flourishing literature attests to its growth. On the other hand, the urology of pregnancy has received relatively little attention.

Crabtree, in his pioneering 1942 monograph "Urological Diseases of Pregnancy" emphasized the paucity of organized information in this area. He believed that lagging interest was due to the conservatism which dominates pregnancy since most obstetrical cases progress normally. If matters took a serious turn, pregnancy was generally interrupted. Leisurely progress may also be attributed to the fact that the average obstetrician has had little opportunity to study urologic disease and most urologists are not conversant with obstetrics. Sudden crises require a consultation which often misses the ideal of a joint conceptualization of the problem by both specialists. Each tends to turn the case over to the other whereas one should strive, under the obstetrician's aegis, for a coordinated effort.

It need hardly be reaffirmed that the pregnant woman may suffer from any urologic disease that affects her when nonpregnant. The problem is compounded, however, not only by the profound physiologic changes of the gravid state but also by the involved presence of the fetus. This combination of factors, unhappily, has retarded progress; particularly since the perceived hazards of diagnostic radiation, cystoscopy and surgical procedures in pregnancy have been tentatively addressed. Anaesthesia in pregnancy, also, has not been fully defined.

This book represents an effort to integrate the understanding of both obstetricians and urologists in the relationship of urologic disorders to pregnancy. The physiologic changes during the gravid state of the kidneys, ureters, bladder and urethra are now better understood and herein described. In former years the urology of pregnancy concerned itself almost wholly with pyelonephritis. Many more disorders are presently considered. In addition, our comprehension of urinary tract infection and its implications in pregnancy has so expanded that several chapters are allocated to it including its pathogenesis, diagnosis, treatment and the significance of uretero-vesical reflux. Urinary tract calculi merited yet another chapter. Repetition was avoided where possible but it was believed important, for example, to separate injuries to the lower urinary tract resulting from pregnancy and the effect on pregnancy of lower urinary tract disorders. Similarly, there are both urologic indications for Cesarean section and the urinary tract complications due to Cesarean section. The vastly increased knowledge and experience in urinary tract oncology with respect to pregnancy and also in sexually transmitted diseases have been described; while problems of labor and delivery relating to urologic understanding are discussed. The new field of prenatal ultrasound examination of the fetus is presented.

As can be seen from the Table of Contents, the special information of several authorities was solicited for chapters on the relation of pregnancy to parenchymal

renal disease, diagnostic imaging of the urinary tract, radio-isotope renography, renal transplantation and anaesthesia. Reviews of the inter-related embryology and the anatomy of the urinary and reproductive systems have been omitted since they are amply available in other texts.

Urology in Pregnancy was designed for use by both obstetricians and urologists as well as for all professionals and students with an interest in either discipline.

Selwyn Z. Freed, M.D.
Norman Herzig, M.D.

此为试读,需要完整PDF请访问: www.ertongbook.com

Contributors

Gerard M. Bassell, M.B., B.S.
Professor of Anesthesiology
Jacobi Hospital
Pelham Parkway at Eastchester Road
Bronx, NY

Robert S. Brown, M.D.
Beth Israel Hospital
Boston, MA

Franklin H. Epstein, M.D.
Beth Israel Hospital
Boston, MA

Selwyn Z. Freed, M.D.
Montefiore Hospital and Medical Center
Bronx, NY

Norman Herzig, M.D.
New Fairfield, CT

Gertie F. Marx, M.D.
Professor of Anesthesiology
Jacobi Hospital
Bronx, NY

John W. Rowe, M.D.
Beth Israel Hospital
Boston, MA

Wilhelm Z. Stern, M.D.
North Central Bronx Hospital
Bronx, NY

Sandor H. Wax, M.D.
Brookdale Hospital and Medical Center
Brooklyn, NY

Zoltan Zarday, M.D.
Bronx, NY

Contents

	Preface	v
	Contributors	vii
CHAPTER 1.	**Physiology of the Kidney in Pregnancy.** John W. Rowe, Robert S. Brown and Franklin H. Epstein	1
CHAPTER 2.	**Hydronephrosis of Pregnancy.** Selwyn Z. Freed	9
CHAPTER 3.	**The Bladder and Urethra in Pregnancy.** Selwyn Z. Freed	22
CHAPTER 4.	**Ovarian Vein Syndrome.** Norman Herzig	32
CHAPTER 5.	**Ureterovesical Reflux in Pregnancy.** Selwyn Z. Freed	41
CHAPTER 6.	**Diagnostic Imaging of the Urinary Tract in Pregnancy.** Wilhelm Z. Stern	48
CHAPTER 7.	**The Use of the Radioisotope Renogram in Pregnancy.** Sandor H. Wax	64
CHAPTER 8.	**Renal Disease in Pregnancy.** John W. Rowe, Robert S. Brown and Franklin H. Epstein	68
CHAPTER 9.	**Acute Hydronephrosis of Pregnancy.** Selwyn Z. Freed	77
CHAPTER 10.	**Urinary Tract Infection in Pregnancy.** Selwyn Z. Freed	80
CHAPTER 11.	**Pathogenesis of Urinary Tract Infection in Pregnant Women.** Selwyn Z. Freed	90
CHAPTER 12.	**Diagnosis of Urinary Tract Infection during Pregnancy.** Selwyn Z. Freed	96
CHAPTER 13.	**Treatment of Urinary Tract Infection in Pregnancy.** Selwyn Z. Freed	107
CHAPTER 14.	**Pregnancy and Urologic Diseases of the Kidney.** Selwyn Z. Freed	114
CHAPTER 15.	**Urinary Tract Calculi in Pregnancy.** Selwyn Z. Freed	135

CHAPTER 16. **Pregnancy in the Presence of Lower Urinary Tract Abnormality.** 150
Selwyn Z. Freed

CHAPTER 17. **Pregnancy and Adrenal Neoplasms.** 156
Selwyn Z. Freed

CHAPTER 18. **Sexually Transmitted Diseases in Pregnancy.** 161
Selwyn Z. Freed

CHAPTER 19. **Injury to the Lower Urinary Tract Resulting from Pregnancy.** 185
Selwyn Z. Freed

CHAPTER 20. **Pregnancy and Ureteral Injuries.** 196
Selwyn Z. Freed

CHAPTER 21. **Urologic Problems of Labor and Delivery.** 208
Norman Herzig

CHAPTER 22. **Urologic Indications for Cesarean Section.** 216
Norman Herzig

CHAPTER 23. **Urologic Indications for Therapeutic Abortion.** 218
Norman Herzig

CHAPTER 24. **Renal Transplantation and Pregnancy.** 220
Zoltan Zarday

CHAPTER 25. **The Relation of Anesthesia to the Urinary Tract during Pregnancy.** 232
Gertie F. Marx and Gerard M. Bassell

CHAPTER 26. **Urologic Benefits of Pre-natal Ultrasound Examination.** 248
Selwyn Z. Freed

Index 253

CHAPTER 1

Physiology of the Kidney in Pregnancy

During normal pregnancy, in the presence of remarkable physiologic alterations, the kidneys continue their precise regulation of the composition and volume of the extracellular fluid (ECF). This chapter will deal with the physiologic basis and clinical relevance of the changes that occur in renal function in the course of a normal pregnancy.

RENAL BLOOD FLOW

Studies seeking to clarify the changes that occur in renal perfusion and glomerular filtration rate (GFR) during pregnancy have had to overcome several methodologic obstacles, including the dilation of the renal pelvis and ureters creating increased dead space and a requirement for high urine flow rates to minimize errors in clearance studies;[1,2] often incomplete bladder emptying; and the variable impact of posture on renal hemodynamics late in pregnancy.[3]

Despite these difficulties several physiologic conclusions have gained general acceptance. One striking feature of the renal changes in pregnancy is their rapid development. Renal plasma flow, as estimated by the clearance of Diodrast or paraaminohippurate, increases by at least 30 to 40% by the end of the 1st trimester of pregnancy.[4-7] Serial studies in the same individuals suggest that this increase in renal plasma flow is even greater than 50%.[8-12] The increase is related, at least in part, to the increased cardiac output which attends early pregnancy.[13-15] The modest reduction in arterial pressure that normally accompanies this increased cardiac output indicates a decrease in total peripheral vascular resistance,[16] a decrease in tone shared by the renal vasculature. At the present time the proposed contributions of high circulating levels of progesterone and of placental-lactogen,[17] a substance with effects similar to growth hormone, to the increased renal blood flow of pregnancy remain speculative.

Despite early studies to the contrary, it now appears that the augmented renal blood flow achieved early in pregnancy is maintained at fairly stable levels to term. It has long been thought that late in pregnancy the weight of the gravid uterus on the vena cava would reduce venous return, and hence renal blood flow, in the supine position. Even this dogma has recently been challenged by the studies of Dunlop.[18] In what appears to be methodologically acceptable studies he has failed to demonstrate a difference in renal plasma flow among sitting, lateral recumbent and supine positions late in pregnancy. There continues to be general agreement, however, that pregnancy results in an exaggeration of the normal decrease in renal blood flow that is associated with assuming the upright posture.[12]

GFR

The increase in renal blood flow in early pregnancy is attended by an equally early 40 to 50% rise in the GFR as estimated by the clearance of either inulin or endogenous creatinine. The increment in GFR has usually been thought to exceed the increase accounted for solely by the increased renal plasma flow.[1,6] Thus, the

filtration fraction, or the portion of the renal plasma flow that is filtered at the glomeruli, would be increased from about 20% to over 30%. This rise may in part be related to the reduction in the concentration of the plasma proteins in pregnancy of approximately 1 gm/dl. This reduction would cause a decrease in plasma oncotic pressure[19] of sufficient proportions to cause a significant increase in net filtration pressure across the glomerular capillary and thus, an increased filtration fraction. However, other studies in which the renal plasma flow increased more than 50% in the 1st trimester found the filtration fraction to be reduced in early pregnancy with a rise to non-pregnant levels in the 3rd trimester.[12]

In a longitudinal study, Davison and Hytten[20] have clarified the influence of methodology and stage of gestation on GFR. They followed 10 women through normal pregnancies with serial measurements of the GFR under conditions of rapid intravenous infusions (8 ml/min for inulin and creatinine clearance) and also with 24-hour urine collections for creatinine clearance during usual daily activity. Each patient was studied, with all three clearances, at 15–18, 25–28, 35–38 weeks gestation and again 8–12 weeks post-partum. These studies indicate that the normal basal GFR of 105–110 ml/min (measured following intravenous infusion) is raised to approximately 170 ml/min by the end of the first trimester and with patients studied in the sitting position there is no appreciable decline as term approaches. In the serial 24-hour creatinine clearance studies, the basal values were slightly lower (98 ml/min), rose 50% in the 1st trimester and then were noted to fall near term to levels 35% above basal. This decrease in the 24-hour creatinine clearances is most likely related to the influence of upright posture on decreasing renal blood flow late in pregnancy.

The increased GFR in pregnancy has substantial clinical significance. As a reflection of the increase, blood urea nitrogen (BUN) and serum creatinine levels fall significantly. These reductions are present by the end of the 1st trimester and persist to term. BUN and creatinine values that would ordinarily be considered normal may be elevated for the pregnant state, serving as an early clue to the presence of renal functional impairment. Sims and Krantz[8] found the mean serum creatinine in pregnancy to be 0.46 ± 0.06 mg/dl as compared to non-pregnant values of 0.65 ± 0.07 mg/dl; and BUN values in pregnancy of 8.7 ± 1.5 mg/dl as compared to controls of 13.0 ± 3.0 mg/dl. In addition to the reduction in these blood tests the increased GFR in pregnancy is important because of its clinical pharmacologic implications. With a 50% increase in GFR there is a substantial increase in the renal excretion of many drugs resulting in lower and possibly sub-therapeutic blood and tissue levels. For example, it is not unusual for patients with recurrent episodes of paroxysmal atrial tachycardia to experience an increased frequency of attacks during pregnancy despite the continued administration of doses of digoxin which were previously effective in controlling arrhythmia. This is due, at least in part, to increased urinary excretion and lower blood levels of digoxin and can often be alleviated by increasing the daily dose by 50%.

VOLUME AND SODIUM HOMEOSTASIS

The increased plasma volume in pregnancy noted above is a reflection of a substantial expansion of the extracellular fluid volume (ECF). Since the size of the extracellular fluid compartment is determined largely by salt intake and excretion, sodium balance has received considerable attention by investigators. During a normal pregnancy about 500–850 mEq of sodium are retained, mostly during the third trimester, and distributed primarily to the mother's ECF and, to a lesser extent, to the conceptus.[1, 21, 22] Salt retention is so prominent a feature of pregnancy that at least 39%[23] and in some series as many as 80%[24] of patients develop edema. However, the amount of salt retained is very small when compared to the increased amounts reclaimed by the renal tubules. As a result of the approximately 50% increase in GFR, there is a 50% increase in the salt load presented to the tubules, which must be

reabsorbed to maintain salt balance and ECF. Thus, in order to prevent the development of marked volume contraction, the kidney must reclaim at least 99% of the increased load of filtered sodium, a process largely attributed to the phenomenon of glomerular-tubular balance, but probably enhanced by several other factors, including increased salt-retaining hormones and the influence of the rise in oncotic pressure in the peritubular capillaries resulting from the high filtration fraction.

In an attempt to clarify the physiologic significance of the salt retention of pregnancy, the renal response to alteration in salt intake in pregnancy has been carefully studied.

Several studies have indicated that the capacity to excrete an acutely administered salt load, whether given in the form of intravenous isotonic, hypertonic or hypotonic solutions, is maintained in pregnancy.[1, 25] Similarly, with regard to more chronic salt loads,[26] pregnant and non-pregnant women on high sodium (300 mEq) diets had similar weight gains and urinary sodium excretions. In studies of salt conservation[26] there was no difference between pregnant and non-pregnant women in the capacity to limit urinary sodium losses on a very low sodium (10 mEq/day) diet. Thus, it would appear that the expanded state of the ECF seen in pregnancy is very efficiently protected from alterations induced by changes in salt intake, in a manner exactly equal to that of non-pregnant women.

The renin-angiotensin-aldosterone system has attracted attention because of its alterations in normal pregnancy and the possibility of a contributory role in the pathogenesis of pre-eclampsia. There is thus a sizeable amount of data on pregnancy related changes in this system that have been analyzed in detail by Chesley[27] and will be reviewed only briefly here. Renin, a proteolytic enzyme of renal origin, is secreted primarily in response to reductions in renal perfusion, whether they be induced by upright posture, salt restriction, diuresis, pharmacologic decrease of systemic blood pressure or constricting lesions of the renal arteries. Renin acts on its substrate in plasma, angiotensinogen, an alpha 2 globulin, to result in the formation of angiotensin I, a decapeptide which is in turn converted, primarily in the pulmonary circulation, to angiotensin II, an octapeptide commonly referred to as angiotensin. This interesting substance is a potent vasoconstrictor agent and also stimulates adrenal production and release of aldosterone. Aldosterone, the major mineralocorticoid in man, acts on the renal tubule to stimulate the reabsorption of sodium from the glomerular filtrate, thus resulting in expansion of the ECF volume with increased renal perfusion and thereby suppression of the release of renin.

All of the components of the renin-angiotensin-aldosterone system, as outlined above, have been found to be present in higher levels in plasma of pregnant women than in the non-pregnant state. Angiotensinogen, the renin substrate, is increased three to fivefold in pregnancy. This increase is noted by the 20th week and there is probably a continued slow rise thereafter.[28–31] The increase of angiotensinogen is thought to be secondary, at least in part, to the high circulating levels of estrogens seen in pregnancy.[29–33] Estrogens, when given to rats, men or non-pregnant women in doses comparable to the levels seen in pregnancy, result in prompt and significant elevations in plasma angiotensinogen,[30, 32, 33] The state of activity of plasma with regard to renin is difficult to assess and is estimated in two different ways. The plasma concentration of the hormone itself can be measured, or, as is more commonly the case, plasma renin activity is estimated by the amount of angiotensin liberated. Thus, the plasma renin activity is dependent not only on the circulating renin level, but also by the amount of renin substrate, angiotensinogen, available. Plasma renin activity (PRA) has uniformly been found to be elevated four to tenfold in pregnancy.[2, 27, 31] There is some disagreement as to whether these high levels, which are present by the end of the 1st trimester, are maintained to term[27, 31] or fall gradually during the 3rd trimester.[34] This elevation of PRA is also likely to be the effect of high estrogens on renin substrate and of the decreased blood pressure

此为试读,需要完整PDF请访问: www.ertongbook.com

stimulating renin secretion.[31] Additionally, plasma and urinary prostaglandin E which enhance renin release are increased in pregnancy[35] and progesterone, an aldosterone antagonist at the level of the renal tubule, may cause renal sodium loss with a resulting stimulation of renin and aldosterone secretion.[27, 31] Several studies indicate that the capacity of plasma renin to respond to changes in salt intake, either salt loading or salt depletion, is intact in pregnancy, although salt-induced suppression of PRA is not quite as complete as in the non-pregnant studies.[26, 27] Studies of the absolute concentration of renin in plasma, as opposed to plasma renin activity, suggest that the concentration of enzyme rises early in pregnancy and then gradually declines toward term.[29, 36, 37]

Angiotensin, the pressor agent resulting from increased PRA also increases fourfold during pregnancy and falls to a threefold increase during the last trimester.[27, 34]

Of interest is the seeming contradiction that despite very high circulating levels of the potent vasoconstrictor angiotensin, blood pressure and peripheral vascular resistance fall during pregnancy. Studies using the infusion of angiotensin have shown that in pregnancy there is a 60% reduction in the sensitivity of the systemic vasculature to the pressor effect of this agent.[27, 38] That this decreased vascular sensitivity is rather specific is suggested by the observation that pregnancy is not associated with any alteration in the vascular response to norepinephrine infusion.[38]

In addition to its vasopressor effects, angiotensin stimulates aldosterone secretion, thus resulting in increased salt conservation. Overactivity of the aldosterone mechanism, in terms of increased plasma aldosterone levels and increased secretion rates of the hormone, has been repeatedly documented in pregnancy,[27, 31] and has served as the basis for the theory that pregnancy represents a state of secondary aldosteronism, thus accounting for the sodium retention. Several lines of evidence tend to favor an alternative explanation that the aldosterone elevation is not physiologically excessive, but is needed to help maintain the expanded ECF volume of pregnancy. When excess mineralocorticoids are administered to volunteers, sodium retention is generally limited to approximately 400 mEq (half the amount of sodium retained in pregnancy) when a poorly understood escape mechanism is activated and further salt accumulation is prevented, despite increased mineralocorticoid levels, by urinary sodium losses. In addition, the administration of an inhibitor of aldosterone synthesis, is associated with a natriuresis in pregnancy, before plasma aldosterone levels fall to the normal non-pregnant level.[39] Several investigators have found that aldosterone production in pregnancy varies inversely with salt intake, both in situations of salt excess and depletion, and that these alterations do not differ substantially from the responses of non-pregnant women to these challenges.[1, 26, 27] Furthermore, administration of small doses of exogenous mineralocorticoids or of ACTH to pregnant women results in sodium retention, weight gain and suppression of endogenous aldosterone secretion; this added evidence of physiologic control is analogous to that of non-pregnant women.[40] On the other hand, the renin-aldosterone system in pregnancy differs from that of the non-pregnant state in several ways: 1) the usual inverse relationship of renin and aldosterone to dietary sodium intake as measured by 24-hour urinary sodium excretion was not found in pregnant women,[31] 2) plasma aldosterone continues to rise in the second and third trimester when renin activity remains unchanged,[41] 3) the kaliuretic activity of mineralocorticoids is blunted during pregnancy,[40] possibly due to antagonism by progesterone and 4) administration of spironolactone or total adrenalectomy failed to modify the sodium retention of pregnant rats.[42] In addition to elevated levels of aldosterone, there is a marked increase in another mineralocorticoid, desoxycorticosterone (DOC), in the plasma and urine of pregnant women during the third trimester.[43] The source of DOC secretion is uncertain, but may be from the fetoplacental unit and also from maternal extra-adrenal 21-hydroxylation of progesterone.[43] Regardless of the source, DOC was not found to be suppressible by either dexamethasone administration or by high

salt intake,[44] yet it is known that pregnant women are quite sensitive to the sodium retaining effect of DOC.[40]

In summary, these studies of volume regulation would seem to indicate that the expansion of the intravascular fluid and ECF compartments in pregnancy is sensed as "normal" by renal and vascular volume sensing mechanisms and that this expanded volume is protected from further increases or from shrinkage in much the same way as protection is afforded to volume in the non-pregnant state. The increased components of the renin-angiotensin-aldosterone system may be the result of the influence of estrogens, progesterone and prostaglandins on the synthesis and action of these substances, or these changes may be compensatory as a response to the increased glomerular filtration of sodium or to a salt losing influence that has not yet been described. It would seem that sodium retention, volume expansion and perhaps even edema, in the absence of hypertension, nephrosis or congestive heart failure, should perhaps be viewed as physiologic and that limitation of salt intake or administration of diuretics should be limited to those patients in whom the development of edema appears excessive.

WATER METABOLISM

Normal pregnancy is associated with water retention in excess of salt retention[45] with a resultant decrease of 4–5 mEq/L in the serum sodium concentration and a decrease of 10 mOsm/kg in plasma osmolality.[46] Most of this excess water retention occurs after the thirtieth week and this new steady state plasma osmolality is protected from further dilution or from concentration in much the same way as in the non-pregnant state. Urinary concentrating ability in response to water restriction is normal in pregnancy,[47] as is the minimal urinary osmolality and maximal urine flow rate after the oral administration of a water load.[48] Although studies measuring antidiuretic hormone (ADH) in pregnancy have not yet been reported, it appears that the most likely explanation for the dilution of the plasma is a resetting of the osmostat such that the normal threshold for the secretion of ADH is lowered from 280 mOsm/kg to a new setting of approximately 270 mOsm/kg.

RENAL HANDLING OF GLUCOSE AND OTHER TUBULAR FUNCTIONS

Glucosuria, in the face of normal serum glucose concentrations, is a common accompaniment of pregnancy. Up to 70% of gravidas[49] excrete greater than 100 mg of glucose daily (the upper limit of normal) and urinary glucose in these patients falls to within the normal range by the end of the 1st post-partum week.[50] There are no data linking the occurrence of renal glucosuria in pregnancy either with perinatal morbidity or mortality, or the subsequent development of diabetes mellitus or renal tubular disorders. The pathophysiology of renal glucosuria in pregnancy is incompletely understood and has been the focus of several studies. Under normal conditions glucose filtered at the glomerulus is reabsorbed by the proximal renal tubule and any glucose found in the urine represents that portion of the filtered load which exceeds the tubular reabsorbing capacity. Tubular reabsorption of glucose is quantitated in terms of number of milligrams absorbed per minute (GFR × plasma glucose concentration − urinary glucose). Under normal conditions tubular reclamation is complete until the plasma glucose exceeds 160–180 mg/dl at which time glucose begins to spill into the urine. The tubular reabsorptive capacity increases as delivery rises (with increased plasma glucose or enhanced GFR)[51] until a maximum tubular reabsorption (TmG) is achieved of approximately 350 mg/min. All further increases in filtered glucose result in quantitative delivery of the increased glucose load into the urine. On the basis of presently available data it appears that during pregnancy the reabsorptive capacity of the tubule for glucose (TmG) increases as GFR rises but that this increment is not as great as in the non-pregnant state.[4, 52, 53] Thus, tubular reabsorptive mechanisms may not be as effective in pregnancy and the kidney can be overwhelmed by the high filtered load of glucose with glucosuria fre-

quently resulting at normal plasma glucose levels (renal glucosuria). The clinical relevance of these changes in the renal handling of glucose in pregnancy are twofold. First, urinary glucose determination becomes unreliable as a diagnostic measure for diabetes mellitus, and second, tests of urine sugar may not be reliable indicators of control of the plasma glucose in diabetic patients. Similarly, any given elevation of blood sugar in a diabetic patient will result in greater urinary losses of glucose and greater losses of water and electrolytes that accompany the glucosuria. Volume depletion and polyuria and polydipsia may thus occur sooner in the pregnant diabetic patient than in the same patient before pregnancy.

Outstripping of the renal tubular reabsorptive capacity may also be the mechanism responsible for the increased urinary losses of amino acids[54] and protein commonly associated with pregnancy. Small amounts of protein are normally filtered and reabsorbed. In pregnancy it is well known that minimal proteinuria (one-plus on qualitative tests) is common and therefore does not always represent a clue to the presence of glomerular disease or preeclampsia.

There are no primary renal acid-base abnormalities associated with pregnancy. There is, however, a common tendency to hyperventilate during pregnancy and the resultant respiratory alkalosis leads to a compensatory renal loss of bicarbonate. The consequent reduction in serum bicarbonate, to a level of 19–20 mEq/L, should be recognized as normal for pregnancy and not mistaken as evidence of metabolic acidosis. This is particularly important in the diabetic patient whose renal glucosuria, coupled with the mildly depressed serum bicarbonate concentration, may lead to the erroneous diagnosis of uncontrolled diabetes.

Uric acid is normally filtered at the glomerulus, reabsorbed along the renal tubules, and secreted in the distal nephron so that about 10% or less of filtered uric acid is found in the urine. In early pregnancy, the serum uric acid level usually decreases by at least 25%, primarily due to the increased GFR, but in part due to decreased tubular reabsorption of uric acid.[55] However, during the 2nd and 3rd trimester the serum uric acid rises toward non-pregnant levels, probably due to increased tubular reabsorption of uric acid.[12, 55] The importance of this finding is to differentiate the moderate increase in serum uric acid found in normal ambulant pregnant women from the exaggerated degree of hyperuricemia associated with preeclampsia.[12] Thus, serial measurements of serum uric acid are probably necessary to have real clinical significance.

References

1. Lindheimer, M.D., and Katz, A.I. Renal changes during pregnancy: Their relevance to volume homeostasis. Clin. Obstet. Gynecol. 2:345:1975
2. Berl, T., and Schrier, R.W. Renal function in pregnancy. In: Renal and Electrolyte Disorders ed. 2. Edited by R. Schrier. Little, Brown & Co., Boston, 1980, p. 471
3. Pritchard, J.A., Barnes, A.C. and Bright, R.N. The effect of the supine position on renal function in the near term pregnant woman. J. Clin. Invest. 34: 777:1955
4. Ferris, T.F. Renal disease. In: Medical Complications during Pregnancy. Edited by G.N. Burrow and T.F. Ferris. W.B. Saunders, Philadelphia, 1975, p. 1
5. Chesley, L.C. Disorders of the kidney, fluids, and electrolytes. In: Pathophysiology of Gestational Disorders. Edited by N.S. Assali. Academic Press, New York, 1972, vol. 1, p. 355
6. Pippig, L.C. Clinique des affectiones rénales pendant la grossesse. Med. Hyg. 27:181:1969
7. Berlin, N.I. *et al.* The blood volume in pregnancy as determined by p32 labelled red blood cells. Surg. Gynecol. Obstet. 97:173:1953
8. Sims, E.A., and Krantz, K.E. Serial studies of renal function during pregnancy and the puerperium in normal women. J. Clin. Invest. 37:1764: 1958
9. DeAlvarez, R.R. Renal glomerulotubular mechanisms during normal pregnancy. I. Glomerular filtration rate, renal plasma flow, and creatinine clearance. Am. J. Obstet. Gynecol. 75:931:1958
10. Assali, N.S., Dignam, W.J. and Dasgupta, K. Renal function in human pregnancy: Effects of venous pooling on renal hemodynamics and water, electrolyte and aldosterone excretion during normal gestation. J. Lab Clin. Med. 54:394:1959
11. Dunlop, W. Renal physiology in pregnancy. Postgrad. Med. J. 55:329:1979
12. Davison, J.M., and Dunlop, W. Renal hemodynamics and tubular function in normal human pregnancy. Kidney Int. 18:152:1980
13. Walters, W.A.W., McGregor, W.G. and Hills, M.

Cardiac output at rest during pregnancy and the puerperium. Clin. Sci. 30:1:1966
14. Vorys, N., Ullery, J.C. and Henusch, G.E. The cardiac output changes in various positions in pregnancy. Am. J. Obstet. Gynecol. 82:1312:1961
15. Adams, J.Q. Cardiovascular physiology in normal pregnancy studies with the dye dilution technique. Am. J. Obstet. Gynecol. 67:741:1954
16. Rovinsky, J.J., and Jaffin, H. Cardiovascular hemodynamics in pregnancy. III. Cardiac rate, stroke volume, total peripheral resistance, and central blood volume in multiple pregnancy. Synthesis of results. Am. J. Obstet. Gynecol. 95:787: 1966
17. Samaan, N., *et al.* Serum placental lactogen. Levels during pregnancy and in trophoblastic disease. J. Clin. Endocrinol. Metab. 26:1303:1966
18. Dunlop, W. Investigations into the influence of posture on renal plasma flow and glomerular filtration rate during late pregnancy. Br. J. Obstet. Gynaecol. 83:17:1976
19. Robertson, E.G. Increased erythrocyte fragility in association with osmotic changes in pregnancy. J. Reprod. Fertil. 16:323:1968
20. Davison, J.M., and Hytten, F.E. Glomerular filtration during and after pregnancy. J. Obstet. Gynecol. Br. Commonw. 81:588:1974
21. Hytten, F.E., and Leitch, I. The Physiology of Human Pregnancy. Second Edition. Blackwell Scientific Publications, Oxford, 1971
22. Plentl, A.A., and Gray, M.J. Total body water, sodium space, and total exchangeable sodium in normal and toxemic pregnant women. Am. J. Obstet. Gynecol. 78:472:1959
23. Thomson, A.M., Hytten, F.E. and Billewicz, W.Z. The epidemiology of oedema during pregnancy. J. Obstet. Gynaecol. Br. Commonw. 74:1:1967
24. Robertson, E.G. The natural history of oedema during pregnancy. J. Obstet. Gynaecol. Br. Commonw. 78:520:1971
25. Lindheimer, M.D., and Weston, P.V. Effect of hypotonic expansion on sodium, water, and urea excretion in late pregnancy: The influence of posture on these results. J. Clin. Invest. 48:947: 1969
26. Bay, W.H., Stein, J. and Ferris, T.F. Response of plasmas renin (PRA) and aldosterone (PA) to changes of sodium (Na) intake in pregnant women. Kidney Int. 6:21A, 1974
27. Chesley, L.C. Renin, angiotensin, and aldosterone. Obstet. Gynecol. Annu. 3:235, 1974
28. Weir, R.J., Paintin, D.B., Robertson, J.I.S., *et al.* Renin, angiotensin and aldosterone relationships in normal pregnancy. Proc. Roy. Soc. Med. 63: 1101:1970
29. Skinner, S.L., Lumbers, E.R. and Symonds, E.M. Analysis of changes in the renin-angiotensin system during pregnancy. Clin. Sci. 42:479:1972
30. Helmer, O.M., and Judson, W.E. Influence of high renin substrate levels on renin-angiotensin system in pregnancy. Am. J. Obstet. Gynecol. 99:9: 1967
31. Wilson, M., Morganti, A.E., Zervoudakis, I., *et al.* Blood pressure, the renin aldosterone system and sex steroids throughout normal pregnancy. Am. J. Med. 68:97:1980
32. Helmer, O.M., and Griffith, R.S. The effect of the administration of estrogens on the renin substrate (hypertensinogen) content of rat plasma. Endocrinology 51:421:1952
33. Newton, M.A., Sealey, J.E., Ledingham, J.C.G., *et al.* High blood pressure and oral contraceptives: Changes in plasma renin and renin substrate and in aldosterone excretion. Am. J. Obstet. Gynecol. 101:1037:1968
34. Gordon, R.D., Symonds, E.M., Wilmhurst, E.G., *et al.* Plasma renin activity, plasma angiotensin, and plasma and urinary electrolytes in normal and toxaemic pregnancy. Clin. Sci. Mol. Med. 45: 115:1973
35. Bay, W.H., and Ferris, T.F. Factors controlling plasma renin and aldosterone during pregnancy. Hypertension 1:410:1979
36. Brown, J.J., Davies, D.L., Doak, P.D., *et al.* Plasma-renin in normal pregnancy. Lancet 2:900:1963
37. Brown, J.J., Davies, D.L., Doak, P.B., *et al.* Serial estimation of plasma renin concentration during pregnancy and after parturition. J. Endocrinol. 35: 373:1966
38. Talledo, O.E., Chesley, L.C. and Zuspan, F.P. Renin-angiotensin system in normal and toxemic pregnancies; III. Differential sensitivity to angiotensin II and norepinephrine in toxemia of pregnancy. Am. J. Obstet. Gynecol. 100:218:1968
39. Ehrlich, E.N. Heparinoid-induced inhibition of aldosterone secretion in pregnant women. Am. J. Obstet. Gynecol. 109:963:1971
40. Ehrlich, E.N., and Lindheimer, M.D. Effect of administered mineralocorticoids or ACTH in pregnant women: Attenuation of kaliuretic influence of mineralocorticoids during pregnancy. J. Clin. Invest. 51:1301:1972
41. Weinberger, M.H., Kramer, N.J., Petersen, L.P., *et al.* Sequential changes in the renin-angiotensin-aldosterone systems and plasma progesterone concentration in normal and abnormal human pregnancy. In: Hypertension in Pregnancy. Edited by M.D. Lindheimer, A.I. Katz and F.P. Zuspan. John Wiley & Sons, New York, 1976, p. 263
42. Alexander, E.A., Churchill, S. and Bengele, H.H. Renal hemodynamics and volume homeostasis during pregnancy in the rat. Kidney Int. 18:173: 1980
43. Nolten, W.E., and Ehrlich, E.N. Sodium and mineralocorticoids in normal pregnancy. Kidney Int. 18:162:1980
44. Nolten, W.E., Lindheimer, M.D., Oparil, S., *et al.* Desoxycorticosterone in normal pregnancy: II. Cortisol dependent fluctuation in free plasma desoxycorticosterone. Am. J. Obstet. Gynecol. 133:644:1979
45. Gray, M.J. Regulation of sodium and total body water metabolism in pregnancy. Am. J. Obstet. Gynecol. 89:760:1964
46. Newman, R.L. Serum electrolytes in pregnancy, parturition and puerperium. Obstet. Gynecol. 10: 51:1957
47. Katz, A.I. Urinary concentrating ability in preg-

nant women with asymptomatic bacteriuria. J. Clin. Invest. 40:1331:1961
48. Lindheimer, M.D., and Weston, P.V. Effect of hypotonic expansion on sodium, water, and urea excretion in late pregnancy: The influence of posture on these results. J. Clin. Invest. 48:947: 1969
49. Fine, J. Glycosuria of pregnancy. Br. Med. J. 1:205: 1967
50. Davison, J.M., and Lovedale, C. The excretion of glucose during normal pregnancy and after delivery. J. Obstet. Gynaecol. Br. Commonw. 81:30: 1974
51. Smith, H.W. Clearances involving active tubular reabsorption. In: The Kidney: Structure and Function in Health and Disease. Oxford University Press, New York, 1951, p. 81
52. Welsh, C.W., and Sims, E.A. The mechanisms of renal glucosuria in pregnancy. Diabetes 9:363: 1960
53. Davison, J.M., and Hytten, F.E. The effect of pregnancy on the renal handling of glucose. J. Obstet. Gynaecol. Br. Commonw. 82:374:1975
54. Christensen, P.J., Date, J.W., Schonhezder, F., *et al.* Amino acids in blood plasma and urine during pregnancy. Scand. J. Clin. Lab. Invest. 9:54:1957
55. Dunlop, W., and Davison, J.M. The effect of normal pregnancy upon the renal handling of uric acid. Br. J. Obstet. Gynaecol. 84:13:1977

CHAPTER 2

Hydronephrosis of Pregnancy

It has been known for over a hundred years that the renal calyces, pelvis and upper ureter dilate significantly in approximately 90% of all pregnant women. This phenomenon is usually noted as early as the 6th to 10th week of gestation and reaches its peak at about 22–24 weeks (Fig. 2.1). At about the 40th week there is usually some diminution followed by a rapid return to normal after the 1st post-partum week, but it may last longer (Fig. 2.2, *A*, *B*, *C*). The renal pelvis and upper ureter are enlarged while the narrowing usually seen at the ureteropelvic junction, normally present in the nonpregnant state, is modified into a wide funnel. The lower ureter, that below the pelvic brim, does not dilate (Fig. 2.3, *A*, *B*). Dilation of the right side is usually considerably more prominent than the left (Fig. 2.4). The presentation and position of the fetus, whether left or right occipital or even breech, shows no causal relationship to the ureteral dilatation.[1] These changes, more prominent in primiparae than in multiparae, often occur less and less in succeeding pregnancies.

These physiologic changes, basically asymptomatic, would not be particularly important were it not for the pathology which often ensues (Fig. 2.5). Complications, especially urinary tract infection, justify further efforts to understand the mechanisms involved. Controversy regarding the etiology of hydronephrosis of pregnancy has a long tradition. Compression of the ureter at the pelvic brim (the *linea innominata*) by the gravid uterus is too well documented to dispute seriously. Nevertheless, other views are worth considering. Besides the possible effects of the hormones of pregnancy, other obstructive phenomena include engorged uterine and ovarian veins, the iliac arteries, and even compression by the uterus against the psoas muscles.[2] Pressure from the bladder, an incidence of vesico-ureteral reflux and urinary tract infection may occasionally be relevant issues.

Basic to the production of urinary tract dilatation at any time is the rate of urine flow vis-à-vis the resistance it encounters. As can be seen from Chapter 1, renal plasma flow and glomerular filtration are substantially increased in pregnancy. Overloading of the tubular reabsorptive mechanism results in increased urine output. Urine overload produces some dilatation of the urinary tract even in the absence of obstruction. For example, this occurs in diabetes insipidus, after massive diuresis and also in instances of excessive intravenous infusion of fluid. Before delineation of the obstructive factors it is of interest to consider the possible endocrine influence on the urinary tract. The urinary and reproductive systems have a common embryologic heritage (the urogenital ridge) and it is therefore logical that both systems should respond to the same hormones.

Changes in the urinary tract in pregnancy are histologically documented. Separations in the fibers of the muscular coats result in a softening of the walls. Hofbauer,[3] in 1928 demonstrated the hyperplasia and hypertrophy of the portion of the ureter in the wall of the bladder. This thickening, considered to be part of the widespread tissue changes due to hormonal influence, has been invoked by some as a possible factor in upper urinary tract dilatation. Though tissue changes do indeed take place this clearly could not be so because the lower ureter above this hypertrophy, but below the pelvic brim, is not dilated in pregnancy.

The inefficacy of drug treatment of ure-

此为试读,需要完整PDF请访问: www.ertongbook.com