

# Metaplasia of the parietal layer of Bowman's capsule: A histopathological survey of the human kidney

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**Summary.** Human kidney sections taken at autopsy were examined to determine the incidence of metaplasia of the Bowman's parietal epithelium. Autopsy records were consulted to determine if there was any correlation between clinical disease, histopathological changes in organ systems and metaplasia of Bowman's capsule. The sections represented both sexes in 9 age groups from 2 to 87 years. The sections were fixed in neutral formalin, embedded in paraffin, sectioned at 6  $\mu$ m, and stained with hematoxylin and eosin. A total of 129 kidney sections, representing 129 individuals, were evaluated. One hundred renal corpuscles were counted per section and the parietal layer of Bowman's capsule was classified as normal (squamous) or metaplastic (cuboidal). Of the 129 kidneys examined, 69 (53%) had metaplasia of Bowman's capsule. Of the 87 male kidneys, 51 (59%) exhibited metaplasia of Bowman's capsule. Of the 42 female kidneys examined, 18 (43%) of the kidneys had metaplasia of Bowman's capsule. On average, in kidneys with metaplasia, 4% of the renal corpuscles had metaplasia of Bowman's parietal layer. The lesion was present in both sexes in all age groups. The autopsy records revealed that there was no common clinical condition associated with the metaplastic lesion, but metaplasia of Bowman's parietal epithelium was consistently present with hepatic congestion and/or fatty changes.

**Key words:** Human kidney - Glomerular capsule - Metaplasia

## Introduction

The parietal layer of Bowman's capsule (pars externa of the renal **glomerular** capsule) in the kidney normally consists of a layer of simple squamous epithelium (Fawcett, 1986). Under certain circumstances, however, this simple squamous epithelium of Bowman's parietal layer may be replaced in part or entirely by simple cuboidal or columnar epithelial cells (Haensly et al., 1982). Different terms have been used to describe this condition. For the sake of consistency in this report, the terms **metaplasia** and **lesion** will be used interchangeably with reference to proximal tubule-like cells composing Bowman's parietal layer.

The parietal layer of Bowman's capsule has been somewhat of an enigmatic tissue ever since **Crabtree** (1941) described the presence of a layer of cuboidal epithelium in the mouse kidney. This metaplasia of the parietal epithelium appeared to be sex and age dependent, being more prevalent in the adult male than in the young male and the young and adult female (Crabtree, 1941; Barberini et al., 1984). No disease process or condition has been associated with this lesion in the mouse kidney.

Metaplasia of the parietal layer of Bowman's capsule has also been reported to occur in the rat kidney. In this species, the lesion has been associated with the aging process (Gray et al., 1974; Bolton et al., 1976; Haley and Bulger, 1983), unilateral nephrectomy (**Lalich** and **Allen** 1971; Andrews 1981) and hypertension (Haensly et al., 1982). A common pathophysiological disturbance that may link these various conditions with the lesion in the rat kidney is not known.

A cuboidal, columnar, or proximal tubule-like epithelium composing the parietal layer of Bowman's capsule has also been reported in the human kidney. The lesion in this case has been variously described as adenomatoid (**Eisen**, 1946; Knowlson and **Cameron**, 1979) and metaplastic (Nachman, 1962; Reidbord, 1968), or

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### Human renal corpuscle metaplasia

simply as prominent parietal epithelium (Gaffney and Panner, 1981; Gaffney, 1985). At present, the etiology of the metaplasia in the human kidney is unknown. In an attempt to obtain more definitive information that may lead to an understanding of the etiology of the lesion, we recently completed a histopathological survey of the human kidney. The observations obtained in this investigation are presented in this report.

#### Materials and methods

Human kidney sections taken at autopsy, and available in one of our laboratories (Dr. Lee's), were examined with the light microscope. The kidneys, collected over an eight-year period (1978-1985), were fixed in neutral formalin, embedded in paraffin, sectioned at 6  $\mu$ m, and stained with hematoxylin and eosin. Excluded from this study were young developing kidneys and sections showing extensive histopathologic conditions and/or autolysis such that the histology of the parietal epithelium could not be determined. One section per kidney was evaluated and only one kidney per individual was used. No distinction was made as to whether the section was from the right or left kidney.

For each renal corpuscle the epithelium of the parietal layer was classified as squamous (normal) or cuboidal (metaplastic). One hundred corpuscles were counted per section and the percentage of capsules with metaplasia was determined. A total of 129 kidney sections were evaluated.

After the kidney sections were examined, the autopsy records were consulted. Disease processes at the time of death and histopathologic conditions recorded at autopsy in the kidney, and in other organ systems, were compared with the observations made on the parietal epithelium.

#### Results

Metaplasia of the parietal epithelium was readily identifiable in the kidney samples used in this study. The

lesion usually involved a few cells (Fig. 1) and occasionally the entire layer (Fig. 2). Occasionally the modified epithelium was observed as continuous with the epithelium of the proximal tubule (Fig. 3).

The quantitative aspects of the survey are summarized in Table 1. No attempt was made to select kidneys from any one age group, and representative kidneys came from nine age groups between 2 and 87 years. Also, no attempt was made to select one sex over the other, and both sexes were represented within each age group. The distribution of age and sex was based solely on the kidney samples that were available for examination.

Of the 129 kidneys examined, 69 (53%) had metaplasia of the parietal epithelium. Of the 87 male kidneys, 51 (59%) exhibited metaplasia of the parietal epithelium. Of the 42 female kidneys examined, 18 (43%) had metaplasia of the parietal epithelium. On average, in the kidneys with metaplasia, 4% of the renal corpuscles showed metaplasia. Except for the 2 to 10 year group, metaplasia of the parietal epithelium was present in all age groups and in both sexes.

The autopsy reports revealed that there was no specific clinical condition or disease associated with metaplasia of Bowman's parietal epithelium. On the other hand, there was one consistent histopathological condition present most frequently in association with the lesion - congestion and/or fatty changes in the liver (Table 1). The fatty changes were recorded as mild to moderate. Of the 69 kidneys with metaplasia of the parietal epithelium, 46 (67%) were associated with hepatic fatty changes, and 28 (41%) were associated with hepatic congestion.

Metaplasia of the parietal epithelium was not observed in 60 kidney sections. Hepatic congestion was present in 4 (7%) of these cases, and hepatic fatty changes were present in 9 (15%) of these cases.

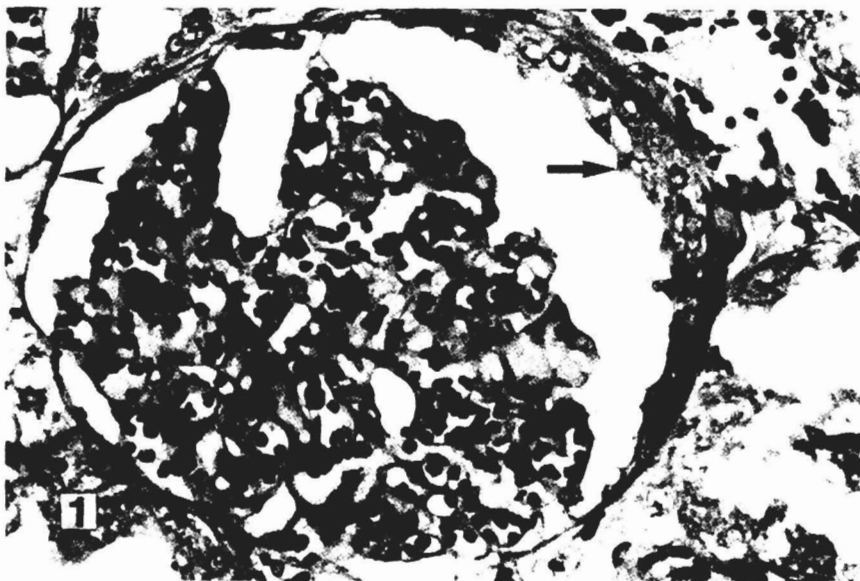
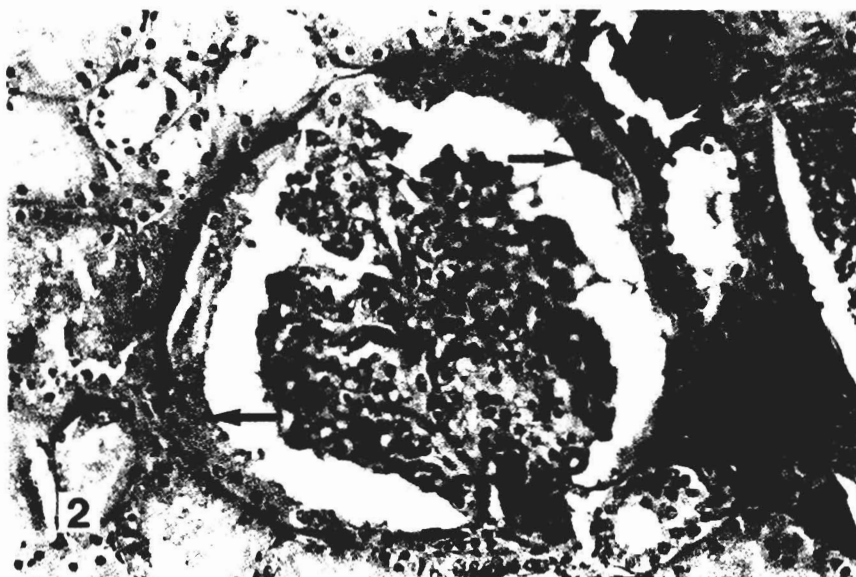
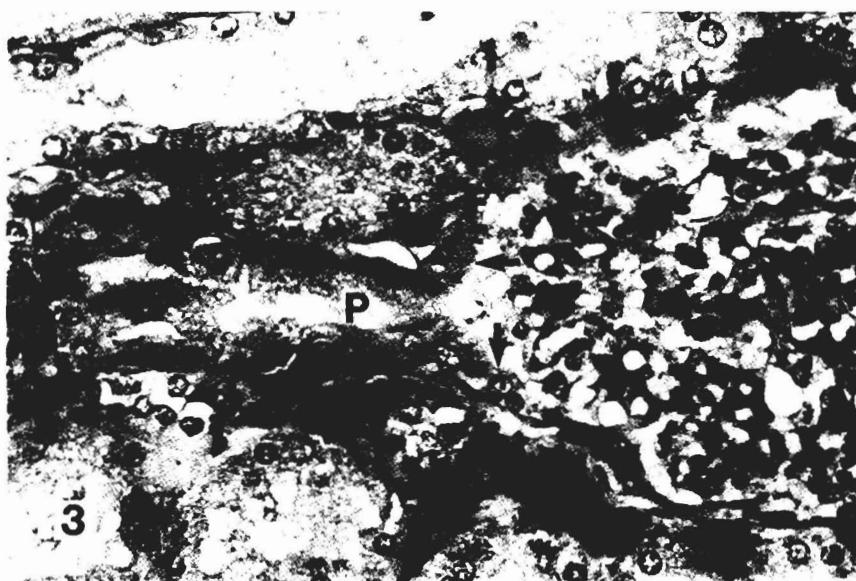


Fig. 1. Renal corpuscle, 87 year-old male. Simple squamous epithelium (arrowhead) and metaplastic epithelium (arrow) of Bowman's parietal epithelium. H.E. x 325



**Fig 2.** Renal corpuscle, 19 year-old male. Entire layer of Bowman's parietal epithelium is composed of metaplastic epithelium (arrows). H.E. x 218



**Fig. 3.** Renal corpuscle and proximal tubule, 43 year-old male. Junction of metaplastic epithelium of Bowman's parietal epithelium (arrows) with the proximal tubule (P). H.E. x 218

*Human renal corpuscle metaplasia***Table 1.** Numbers of human kidneys with metaplasia of the glomerular capsule, mean percentages of glomerular capsules with metaplasia and numbers of livers from the same patients with congestion and fatty changes.

Age (years)	Sex	N <sup>a</sup>	Kidneys with metaplasia	Mean percentages of glomerular capsules with metaplasia	Number of livers with: <sup>b</sup>	
					Congestion	Fatty Changes
2-10	M	3	2	3	2	0
	F	1	0	—	0	0
11-20	M	9	5	4	0	5
	F	3	2	3	1	0
21-30	M	27	13	4	3	10
	F	9	2	5	1	1
31-40	M	15	9	3	2	8
	F	6	2	4	0	2
41-50	M	10	5	4	2	3
	F	4	2	3	0	2
51-60	M	6	5	2	3	3
	F	6	3	2	2	1
61-70	M	4	2	5	0	2
	F	1	1	1	0	1
71-80	M	9	6	4	5	3
	F	10	5	2	2	4
81-87	M	4	4	3	4	0
	F	2	1	4	1	1
2-87	M	87	51	4	21	34
	F	42	18	3	7	12
Total	—	129	69	4	28	46

<sup>a</sup>Number of patients, one kidney per patient<sup>b</sup>Obtained from autopsy reports**Discussion**

Eisen (1946) was one of the first investigators to describe metaplasia of the parietal layer of Bowman's capsule in the human kidney. The lesion was present in a 54 year-old woman with carcinoma of the gallbladder, the only extrarenal factor present. Since that time the renal lesion has been reported in conjunction with other malignancies: a 16 year-old male with an adrenal tumor (Chappell and Phillips, 1950); a 6 month-old male with a primary carcinoma of the liver (Nachman, 1962); a 63 year-old female with a cholangiocellular liver cancer (Eulderink, 1964); carcinoma of the ovary in a 40 year-old woman (Gordon, 1962); carcinoma of the heart in a 73 year-old female (MacPherson, 1963); and a squamous cell carcinoma of the esophagus in a 63 year-old female (Reidbord, 1968). In most of these cases there was a metastasis to the liver. The possibility that liver cancer might be involved in the etiology of the lesion was suggested from these studies (Von Scheele, 1967). To test this hypothesis, an estimate was made of the frequency of the renal lesion in 100 cases of primary liver cancer (Von Scheele, 1967). In none of these cases was metaplasia of the parietal layer of Bowman's capsule present. The author concluded that the association of the renal lesion with liver tumors was a coincidence.

In the study of 77 human renal biopsy specimens, Gaffney (1982) observed 41 with "prominent parietal epithelium" (PPE) of the glomerular capsule, present in various pathological conditions of the kidney itself. Gaffney was of the opinion that the PPE occurs as the result of glomerular injury associated with the existing renal pathology. Finckh and Joske (1954) had observed metaplasia of Bowman's parietal epithelium in four teenage diabetic children. In the latter, there was no clinical evidence of renal disease.

There appears, then, to be a wide spectrum of clinical conditions that may play a role in the development of metaplasia of Bowman's parietal epithelium. The data presented in this paper agree with this observation because there was no clinical condition specifically associated with the lesion. Our observations, however, demonstrated that the presence of hepatic congestion and fatty changes is a histopathological condition that has not been previously demonstrated and is associated with the renal lesion with a high frequency. The hepatic condition might be an important factor in the transformation of the parietal layer of Bowman's capsule from a layer of simple squamous epithelium to a layer of simple cuboidal epithelium. Since these hepatic changes were mild to moderate, the livers might have been in the early stages of more severe

## Human renal corpuscle metaplasia

histopathological conditions. At the same time, the percentages of the renal glomerular capsules with metaplasia was relatively small, perhaps reflecting that the capsules were also in the early stages of pathophysiological change.

It is well-known that the liver participates in several ways with lipid metabolism, and derangement of the metabolic regulatory pathways could interfere with the secretion of lipoprotein, which in turn could lead to disturbances in hepatic function referred to as "fatty liver", "fatty degeneration", or "fatty metamorphosis" (Alpers and Sabesin, 1982). Such fatty changes occur in a variety of conditions: alcohol abuse, diabetes mellitus, starvation, morbid obesity, adrenocorticoid therapy, and drug toxicity (Bynum, 1984). Renal dysfunction, in turn, is itself a consequence of liver disease. One of the first manifestations of renal dysfunction is a disturbance in the management of sodium and water excretion (Flamenbaum and Schmitt, 1976). The major function of the renal proximal tubule is the reabsorption of about three-fourths of the glomerular filtrate, primarily the reabsorption of Na, Cl, and HCO<sub>3</sub> (Weinstein and Windhager, 1985). Sodium retention is a major pathophysiological disturbance in certain hepatic disease which show fatty changes in the liver (Epstein, 1982). Since the metaplastic tissue of Bowman's parietal layer structurally resembles the proximal tubular epithelium (Haensly et al., 1982), this tissue may also function like the proximal tubular epithelium, being part of or the main reason for sodium retention in certain diseases in which the liver is also involved. It is estimated that the human kidney contains about one million nephrons (Smith, 1951). In the data reported in the present study, the mean percentage of nephrons which showed metaplasia was 4%. This would affect about 40,000 nephrons. Others have reported that the lesion involved more than 50% of the nephrons (Nachman, 1962; MacPherson, 1963). In such cases, more than one-half million nephrons could participate in the pathophysiology that might be associated with metaplasia of Bowman's parietal layer of epithelium.

Our current studies are aimed at determining the role that this lesion might play in renal dysfunction.

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