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Renal Papillary Morphology in Adults

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Summary. Renal papillary morphology and distribution have been analysed endoscopically in 50 adult autopsy kidneys. Concave papillae of the refluxing type were found with greater frequency in the adult kidneys than had been reported by others in children. A further type of calyx lacking a true papilla, not previously described in children, was occasionally observed. It therefore seems doubtful that all pyelonephritic scars detected at autopsy in adult kidneys have arisen during infancy. Further studies will be required to elucidate the role of papillary morphology in the pathogenesis of adult pyelonephritis.

Key words: Adult kidney, Renal endoscopy, Papillary morphology, Reflux nephropathy, Pyelonephritis.

Introduction

The shape of the renal papillae is now thought to play a key role in the pathogenesis of pyelonephritic scarring in children with vesico-ureteric reflux (VUR). Papillae with a convex area cribrosa prevent intrarenal reflux (IRR) by a valve-like mechanism. In contrast, concavely shaped compound papillae allow backflow of urine into the renal parenchyma during micturition. This mechanism may initiate pyelonephritic scarring [4, 8–12]. Since the incidence of VUR is much higher in children than in adults, the morphological studies reported to date have been in neonates and young children [2, 3, 5, 7, 14]. To investigate the importance of papillary configuration in the pathogenesis of ascending pyelonephritis in adults we have made a detailed analysis of the distribution and shape of the renal papillae in a group of adult autopsy kidneys.

Material and Methods

Fifty macroscopically normal adult kidneys (35 males, 15 females) removed at autopsy within 48 h of death were studied. Forty-seven were from patients over 60 years old. The ureter was cut 10 cm below the pelvi-ureteric junction and the renal artery divided near the aorta. A small incision was made in the ureter just below the pelvi-ureteric junction and a slim cystoscope (Storz) introduced into the pelvis. Cellular debris was rinsed out of the pelvis and calyces by water passed through the cystoscope at a maximum pressure of 60 cm H_2O. The papillae were photographed and classified endoscopically according to site, shape and type of excretory duct openings. (Olympus Pen-S for Medical use, Type I). Finally, each kidney was perfused through the renal artery with physiological saline (160 cm H_2O pressure) and the renal pelvis infused with a black ink-water suspension (80 cm H_2O pressure) for 1 h.

Results

Papillae were classified endoscopically as follows:

Type 1: Simple Convex Papillae: One single cone-shaped papilla with a convex area cribrosa protruding into the calyx (Fig. 1a).

Type 2: Compound Convex Papillae: Two papillae fused into a ridge-like compound papilla with a mainly convex surface (Fig. 1b).

Type 3: Compound Concave Papillae: Ridge-like compound papilla but with a concave area cribrosa (Fig. 1c).

Type 4: Compound Star-like Papillae: Three (or occasionally four) papillae fused into a star-like compound with a concave area cribrosa (Fig. 1d).

Type 5: Compound Papillae with a Complex Shape: Two or more papillae fused in a variety of ways, joined either by a bridge of papillary substance or by filamentous material (Fig. 1e).

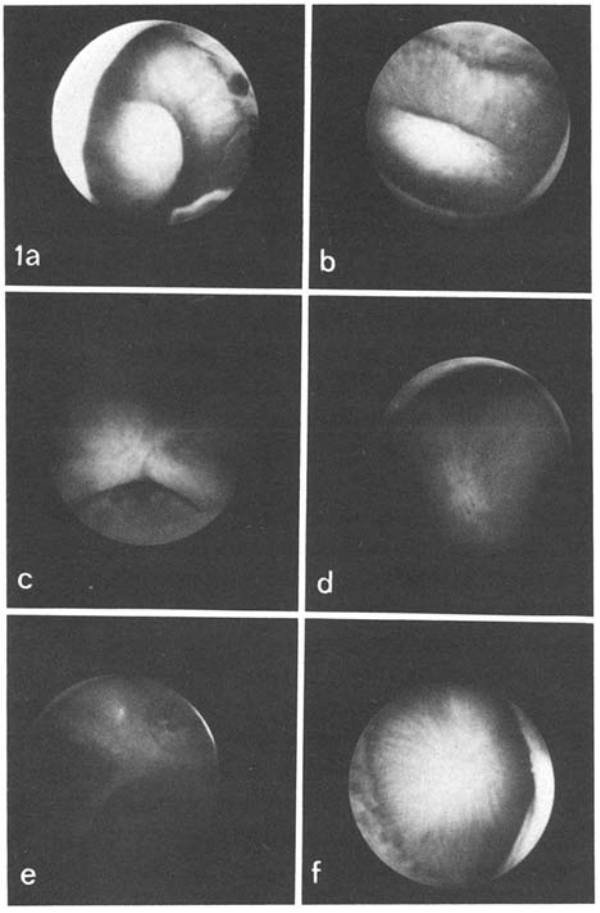


Fig. 1a–f. Endoscopic classification of papillae. **a** simple convex, (Type 1), **b** compound convex (Type 2), **c** compound concave (Type 3), **d** compound star-like (Type 4), **e** compound with a complex shape (Type 5), **f** concavity instead of a papilla (Type 6)

Type 6: Concavity Instead of a Papilla: On looking into a calyx there is a flat or concave area cribrosa sometimes surrounded by a narrow rim of tissue. A true papilla is missing (Fig. 1f).

The distribution of the various types of papilla is summarised in Table 1. For this purpose the kidney has been divided into upper and lower poles and a mid-zone as suggested by Ransley and Risdon. The compound concave papilla (Type 3) was the most frequently found type in all three areas, especially in the mid-zone, followed by the convex conical and convex ridge-like papillae (Types 1 and 2). Star-like papillae (Type 4) were found in smaller numbers in all areas with slight predominance at the poles. Compound papillae with a complex configuration (Type 5) were exclusively seen at the poles, particularly the upper pole. Calyces with a concavity instead of a papilla (Type 6) were present in all areas but were most common in the mid-zone. Three kidneys contained only compound papillae with a concave area cribrosa and complex papillae (types 3, 4 and 5). In two kidneys only simple or compound papillae with a convex surface were observed.

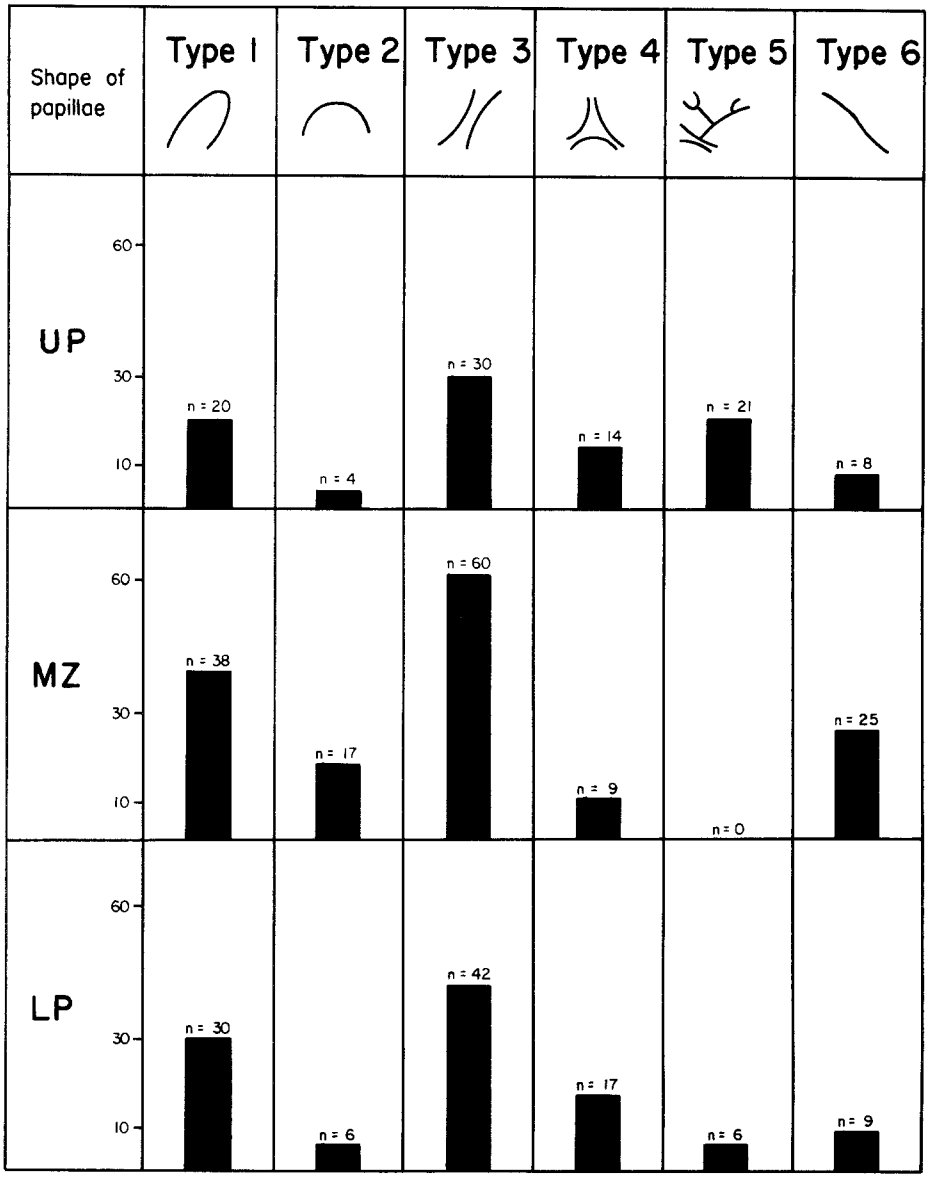
Endoscopically three forms of excretory duct openings were distinguished – round, oval and slit-like (Fig. 2a, b, c). The distribution of the different forms of duct openings in relation to the various types of papilla is summarised in Table 2. In papillae of Types 1 and 6 round orifices, mainly situated in the centre, predominated whereas a few oval or slit-like openings occurred particularly at the periphery. Ridge-like and star-like papillae (types 2, 3 and 4) usually had both round and oval orifices. In compound papillae with a complex configuration (Type 5) all three types of opening were frequently observed together with slit-like openings, being more common in the part of the papilla which appeared stretched. In all compound papillae, regardless of their configuration, round duct openings were mainly situated peripherally, with slit-like orifices predominantly in the centre.

The intrapelvic infusion of a black ink-water suspension did not allow us to establish any relationship between papillary configuration and IRR. It may be that epithelial cell debris washed into the excretory ducts when the pelvis was rinsed with water obstructed the collecting ducts and prevented pyelo-tubular backflow.

Discussion

Our findings in adults were similar to those of Ransley and Risdon in infants where compound papillae with a complex configuration occur exclusively in the polar areas [7]. In adults, however, papillae with a convex area cribrosa (Types 1 and 2) were less frequently observed than in children. Concave papillae (Types 3 and 4) were more numerous in adults and, in contrast to infants, were predominantly found in the mid-zone (Table 3). Calyces ending in a concavity without a true papilla (Type 6) were not described by Ransley and Risdon but may be part of the compound papilla of concave type mentioned by Tamminen and Kaprio [6, 7, 14].

Round to oval excretory duct openings in concavely shaped papillae were found with about the same frequency in our adult series as in the study of infants and children reported by Tamminen and Kaprio [14]. Round and oval orifices seemed to be more frequent in the simple convex papilla in adults, but slit-like openings were rarely seen in adult papillae, particularly those with a convex surface. The difference between our findings and those of Tamminen and Kaprio may be due to the method of study. The scanning electron microscope which they used gives greater resolution than the optical system of an endoscope. Endoscopy is performed under hydrostatic pressure and this may close some of the openings, particularly those which are slit-like, apparently reducing their frequency [8]. The attempt in our study to establish a relationship between IRR, papillary configuration and the shape of the duct openings by the infusion of black ink-water failed. Ransley and Risdon also found this [8], though Tamminen and



UP = Upper pole MZ = Mid-zone LP = Lower pole

Table 1. Distribution of the various types of papillae

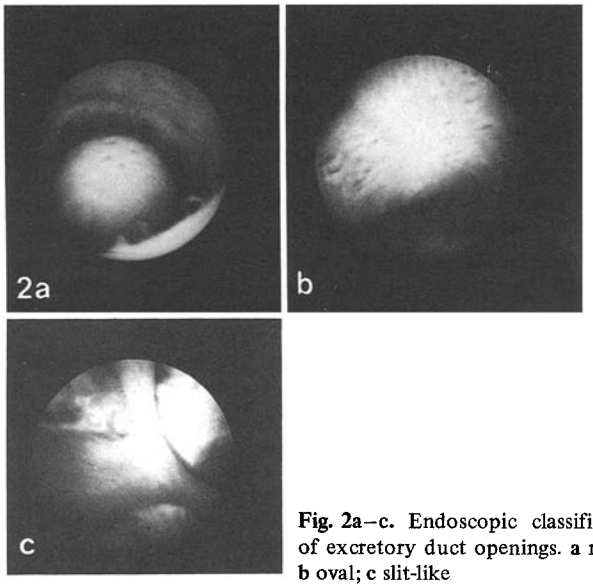


Fig. 2a–c. Endoscopic classification of excretory duct openings. **a** round; **b** oval; **c** slit-like

Kaprio [14] as well as Funston [3] had more success following saline perfusion of the kidneys.

The most striking contrast between papillary configuration in adult and infantile kidneys was the predominance of concave papillae in adults. This may be a technical difference. Previous investigators studied the very small infantile papillae after dissection and formalin fixation [7, 14]. Our method of examining intact unfixed kidneys by endoscopy may have allowed more detailed observation. Some of the discrepancy may also be due to renal growth. It seems likely that compound convex papillae become concave as they enlarge. This idea is also supported by the distribution of the various types of duct openings. It is striking that the peripheral openings on to the concave surface were round whereas the centre of the concavity contained mainly oval and slit-like orifices. These oval and slit-like forms could be due to the expansion of round openings in the centre of what were initially compound papillae

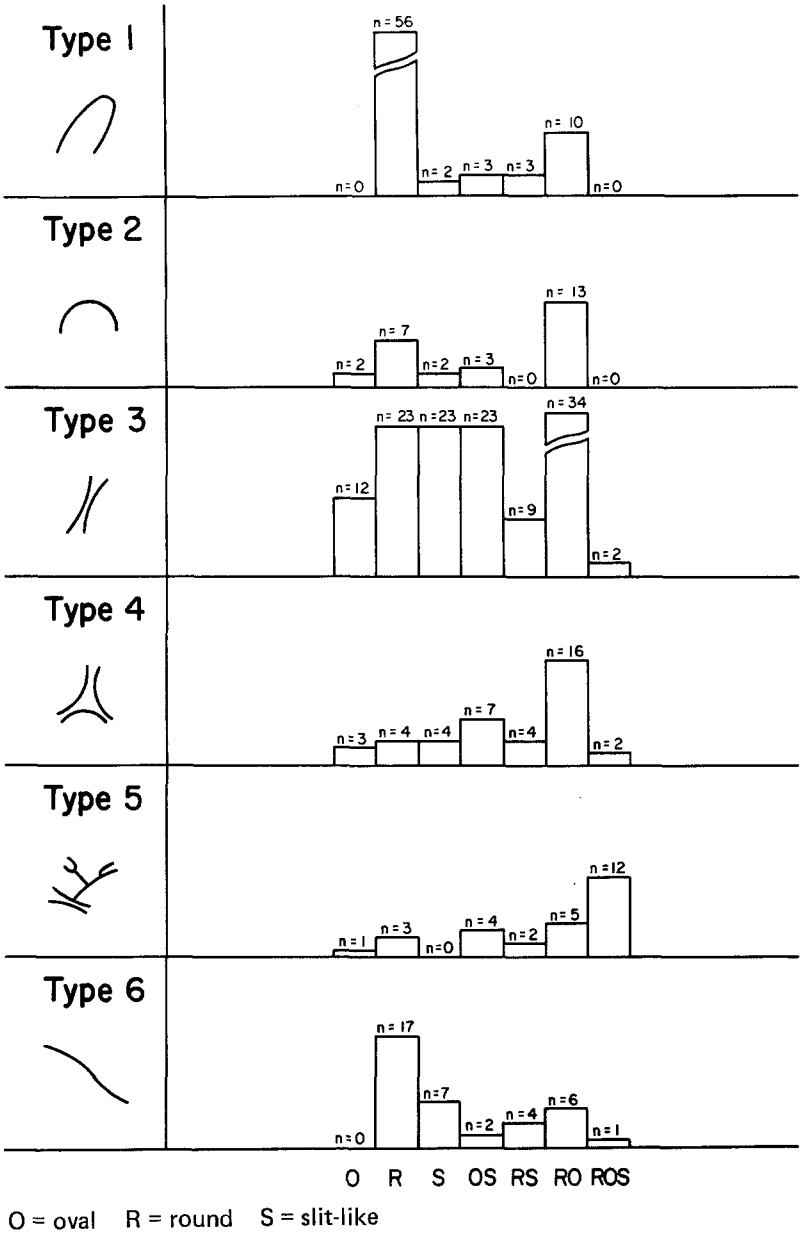


Table 2. Distribution of the different forms of duct openings in relation to the various types of papillae

Table 3. Comparison of the distribution of various types of papillae between adults and children (in percent)

		convex simple and compound	concave compound	complex	concavity instead of a papilla
UP	children	16.2	1.2	6.7	–
	adults	6.7	12.4	5.9	2.2
MZ	children	47.0	0.4	–	–
	adults	15.5	19.4	–	7.0
LP	children	24.5	2.0	2.0	–
	adults	10.1	16.6	1.7	2.5

UP = upper pole; MZ = mid-zone; LP = lower pole

with a convex surface (Type 2). In 12% of calyces there was a concavity instead of a papilla. This finding may be the result of atrophy, papillary sequestration or maldevelopment. Our observations in dieseased kidneys with hydronephrosis, analgesic nephropathy or vascular scarring indicated that in those conditions most of the papillae were altered. We therefore assume that in the otherwise normal adult kidneys, which form the basis of this communication, the occurrence of rare apapillary calyces represents a form of developmental defect.

Concavely shaped papillae are thought to be an important pathogenetic factor in pyelonephritic scarring in patients with VUR [4, 11, 12]. Investigations in children suggest that pyelonephritic scars related to VUR and urinary tract infections are unlikely to develop after the age of five years [1, 13]. However, our study has shown that concave papillae are more frequently observed in adult kidneys than in infants. This makes it very doubtful that all pye-

lonephritic scars detected at autopsy are of infantile origin. Further investigations are required to show whether there is a correlation between papillary configuration and acute ascending pyelonephritic inflammation in adult kidneys.

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