



# Surgical treatment reduces blood pressure in children with unilateral congenital hydronephrosis

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## Summary

### Objective

Renal disorders can cause hypertension, but less is known about the influence of hydronephrosis on blood pressure. Hydronephrosis due to pelvo-ureteric junction obstruction (PUJO) is a fairly common condition (incidence in newborns of 0.5–1%). Although hypertensive effects of hydronephrosis have been suggested, this has not been substantiated by prospective studies in humans [1–3]. Experimental studies with PUJO have shown that animals with induced hydronephrosis develop salt-sensitive hypertension, which strongly correlate to the degree of obstruction [4–7]. Moreover, relief of the obstruction normalized blood pressure [8]. In this first prospective study our aim was to study the blood pressure pattern in pediatric patients with hydronephrosis before and after surgical correction of the ureteral obstruction. Specifically, we investigated if preoperative blood pressure is reduced after surgery and if split renal function and renographic excretion curves provide any prognostic information.

### Patients and methods

Twelve patients with unilateral congenital hydronephrosis were included in this prospective study. Ambulatory blood pressure (24 h) was measured preoperatively and six months after surgery. Preoperative evaluations of bilateral renal function by Tc99m-MAG3 scintigraphy, and renography curves, classified according to O'Reilly, were also performed.

### Results

As shown in the summary figure, postoperative systolic ( $103 \pm 2$  mmHg) and diastolic ( $62 \pm 2$  mmHg)

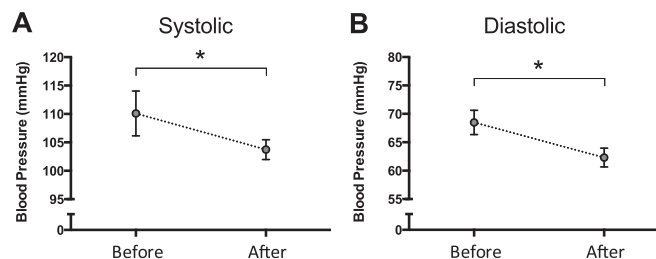
blood pressure were significantly lower than those obtained preoperatively ( $110 \pm 4$  and  $69 \pm 2$  mmHg, respectively), whereas no changes in circadian variation or pulse pressure were observed. Renal functional share of the hydronephrotic kidney ranged from 11 to 55%. There was no correlation between the degree of renal function impairment and the preoperative excretory pattern, or between the preoperative excretory pattern and the blood pressure reduction postoperatively. However, preoperative MAG3 function of the affected kidney correlated with the magnitude of blood pressure change after surgery.

### Discussion

Correction of the obstruction lowered blood pressure, and the reduction in blood pressure appeared to correlate with the degree of renal functional impairment, but not with the excretory pattern. Thus, in the setting of hypertension, it appears that the functional share of the hydronephrotic kidney should be considered an indicator of the need for surgery, whereas the renography curve is less reliable. The strength of the present study is the prospective nature and that ambulatory blood pressure monitoring was used. Future longitudinal prolonged follow-up studies are warranted to confirm the present findings, and to understand if a real nephrogenic hypertension with potential necessity of treatment will develop.

### Conclusion

This novel prospective study in patients with congenital hydronephrosis demonstrates a reduction in blood pressure following relief of the obstruction. Based on the present results, we propose that the blood pressure level should also be taken into account when deciding whether to correct hydronephrosis surgically or not.



Figure

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## Introduction

Hydronephrosis due to obstruction at the level of the pelvo-ureteric junction (PUJO) is a fairly common condition, with an incidence in newborns of approximately 0.5–1%. The obstruction is likely to be partial, unilateral, and preferably left-sided (2:1). It has been shown that the function of the hydronephrotic kidney in many cases remains surprisingly well preserved for several years [9,10]. This observation has led to a worldwide trend towards conservative management. The long-term physiological consequences of this new treatment policy are not known, but recent experimental studies have clearly shown an increased cardiovascular risk later in life [6,7,11].

Many renal parenchymal disorders can cause hypertension, but currently only limited data are available to support an association between PUJO and elevated blood pressure [12]. There are, however, case reports on a limited number of adults with hypertension obviously caused by hydronephrosis, since the patients became normotensive after nephrectomy or pyeloplasty [1,3]. In a retrospective study of 227 pediatric patients undergoing surgery due to unilateral hydronephrosis, 5% were found to be hypertensive preoperatively, and in 90% of these children blood pressure was normalized after surgery [2]. On the other hand, other investigations have shown no hypertensive effects of hydronephrosis [13].

According to the literature, the incidence of hypertension in unilateral hydronephrosis is not particularly high, although ambulatory blood pressure measurements have not been used as standard procedure in this patient group. Still, in a substantial number of patients and in experimental studies with PUJO, high blood pressure is reversible by surgical correction of the obstruction [3,8].

Blood pressure fluctuates continuously over time, either spontaneously or in response to a variety of external stimuli, of which physical activity is a major determinant [14]. Carrying out repeated measurements with ambulatory blood pressure monitoring (ABPM), using invasive [15] or non-invasive devices [16], provides more representative values, and permits the observation of blood pressure variability during activity and sleep. The performance of non-invasive ABPM during awake and sleeping periods is currently regarded as standard practice in the detection and management of hypertension. Although hydronephrosis have been associated with hypertension, this has not been substantiated by prospective studies in humans. In the present study we therefore aimed to determine the effects of surgical management on blood pressure in children with PUJO, using ABPM before surgery and again 6 months later.

## Patients and methods

This prospective study was conducted in Sweden at the Pediatric Surgery Department of Uppsala University Children's Hospital in Uppsala and the Pediatric Surgery Department of Astrid Lindgren's Hospital in Stockholm. Twelve patients were included between 2007 and 2014. Patient ages ranged from infancy to 13 years.

In order to match our experimental studies of hydronephrosis, all patients included in this study were boys.

Only children with unilateral congenital hydronephrosis were included. Thus, children with bilateral hydronephrosis were excluded, as were those who had any relevant concomitant disease or previously known and treated hypertension. In eight patients the hydronephrosis was located to the left kidney whereas in four patients the hydronephrosis was right-sided.

Ambulatory blood pressure was measured preoperatively during 20–24 h, including the full nocturnal sleeping period, with readings obtained every 20 min during daytime and every hour during nighttime. The PUJO was then relieved surgically. Laparoscopic pyeloplasty was performed in four patients (33.3%) while traditional open pyeloplasty was done in eight patients (66.6%). Ambulatory blood pressure was then measured again for 20–24 h 6 months postoperatively. This was done as an outpatient procedure without hospital admission. The same consultant pediatric nephrologist evaluated both preoperative and postoperative blood pressure curves for all of patients.

Preoperative Tc-99m-labeled MAG3 (mercaptoacetyl-triglycine) renography with forced diuresis was also performed in all patients as part of routine evaluation. The examination was performed in a standardized fashion with hydration of the patient, either orally by 15 mL/kg body weight or intravenously to the same extent during 1 h prior to the investigation. Intravenous injection of the tracer (1 MBq/kg body weight, according to standard protocol) was given at the beginning of the examination and registration (Siemens eCAM gamma camera, Munich, Germany) was begun and continued for 30 min or sometimes longer. After 15 min, furosemide (0.5 mg/kg body weight) was given intravenously. The investigation gives information about the split function of the kidneys and the elimination of the tracer, the renography curve. These curves were classified according to O'Reilly [17], that is, the pattern was described as normal (I), obstructed (II), dilated non-obstructed (IIIa), or equivocal (IIIb). Both a pediatric nephrologist and a nuclear medicine specialist assessed the split renal function.

## Statistical analysis

Statistical analyses were performed using GraphPad Prism 6 for Mac OS X (version 6.0b; San Diego, CA, USA). Non-parametric Wilcoxon matched-pairs signed rank tests were used to test for changes in systolic and diastolic blood pressure after surgery. Pearson's *R* analysis was used for linear regression and to determine any potential association between variables. Values are presented as mean  $\pm$  95% CI. Statistical significance was defined as  $p < 0.05$ .

## Ethics

This study was approved by the regional ethical review board in Uppsala, Sweden (EPN; Protocol Number 2011/267). Every child's guardian gave informed consent. The study adhered to the principles of the Declaration of Helsinki.

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