Section A-Research paper

Pediatric Renovascular Hypertension: a review

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Abstract

"Pediatric renovascular hypertension (PRH)" is a rare but potentially dangerous syndrome that, if not identified and treated right away, can result in problems like chronic renal disease and cardiovascular disease. The pathogenesis, clinical manifestation, diagnosis, and therapy of PRH are discussed in this review, with an emphasis on evidence-based methods for treating this condition. PRH has a complicated etiology that includes a number of variables, including renal artery stenosis, RAAS activation, and oxidative stress. Depending on the underlying cause of the hypertension, the clinical presentation may differ, but it may include signs and symptoms like headaches, exhaustion, and breathing problems. Imaging tests like renal Doppler ultrasound and magnetic resonance angiography may be part of the diagnostic evaluation. Antihypertensive drugs, revascularization techniques, and lifestyle changes are all available as treatments. Maintaining blood pressure management and identifying issues early require close monitoring and follow-up. To manage juvenile renovascular hypertension as effectively as possible, pediatricians, nephrologists, radiologists, and surgeons must work together.

Keywords: renovascular hypertension, pediatric, pathophysiology, diagnosis, treatment

Introduction:

Untreated "*Pediatric renovascular hypertension* (PRH)" can have a major impact on morbidity and mortality. It is a rare but potentially dangerous illness. In order to activate the "*Renin-Angiotensin-Aldosterone System* (RAAS)" and decrease renal perfusion, it is

described as hypertension brought on by renal artery stenosis or blockage (1). Renovascular hypertension is thought to account for between 1 and 5 percent of all instances of hypertension in children (2).

There are two basic groups for the genesis of PRH: congenital and acquired. Fibromuscular dysplasia and Takayasu arteritis are examples of congenital causes, whereas renal artery thrombosis, embolism, or iatrogenic injury following treatments like renal biopsy or nephrectomy are examples of acquired causes (1).

PRH can manifest clinically in a variety of ways, with some individuals exhibiting no symptoms at all while others show signs of severe hypertension, renal failure, or even heart failure. Headache, exhaustion, stomach pain, and hematuria are typical signs and symptoms (3). Typically, Doppler ultrasound, computed tomography angiography, or magnetic resonance angiography are used to diagnose renovascular hypertension (4).

The prevention of long-term consequences such end-stage renal disease, stroke, and myocardial infarction depends on the early identification and adequate therapy of PRH. Depending on the underlying cause and degree of hypertension, there are various treatment options for PRH. Blood pressure is often managed with drugs such "angiotensin receptor blockers (ARBs)", and in more severe situations, surgery like renal artery angioplasty and stenting or surgical revascularization may be necessary (5).

Despite recent advancements in the treatment of PRH, the best management approaches remain controversial. This is mainly because there isn't as much high-quality research available due to the condition's rarity. The majority of the research in this field has been done on adults, thus there is a need for more studies that concentrate exclusively on young patients (6).

Pathophysiology:

The occlusion of the renal arteries or veins, which reduces blood flow to the kidneys, causes PRH, an uncommon form of hypertension (11). Between 5% and 10% of pediatric hypertension cases are caused by PRH (12). Depending on where the vascular obstruction occurs, PRH can be divided into two types: "*Renal Artery Stenosis* (RAS)" and "*Renal Vein Thrombosis* (RVT)".

RAS accounts for around 80% of PRH cases, making it the most frequent cause. Atherosclerosis, fibromuscular dysplasia, vasculitis, or trauma can all result in RAS. RAS is most frequently caused by atherosclerosis in adults, while it is uncommon in children. A non-inflammatory, non-atherosclerotic condition known as fibromuscular dysplasia affects the walls of medium and large arteries, including the renal arteries. In the afflicted vessels, it may result in stenosis or aneurysms. RAS can be brought on by vasculitis, an inflammatory illness that affects blood vessels. Stenosis and PRH can also result from trauma to the renal artery (12-15).

RVT is a less frequent cause of PRH and is more prevalent in newborns and young children. RVT may result from renal vein compression, infection, thrombophilia, or dehydration (11). RVT can be brought on by dehydration because it can cause blood clots to develop in the renal veins. Sepsis can result in endothelial dysfunction and inflammation, which can clog the renal veins. RVT may be predisposed to by thrombophilia, a disorder in which the blood has an increased propensity to clot. A growth or tumor close to the renal vein may cause renal vein compression (11-15).

The "*sympathetic nervous system* (SNS)" and (RAAS) are both activated in the pathophysiology of PRH (16). The RAAS is activated as a result of the reduced blood flow to the kidneys brought on by the vascular blockage, which boosts the production of angiotensin II and aldosterone. A powerful vasoconstrictor, angiotensin II can raise blood pressure (13). Aldosterone causes the kidneys to absorb more salt and water, which causes the extracellular fluid volume to increase and the blood pressure to rise (14). Vasoconstriction, increased heart rate, and higher cardiac output are all caused by the SNS being activated, all of which help to raise blood pressure (15).

Inflammation, in addition to the RAAS and SNS, may contribute to the pathophysiology of PRH. Endothelial dysfunction and damage brought on by inflammation can result in blood clots, RAS, or RVT development (16). Interleukin-6 (IL-6) and other inflammatory cytokines have been discovered to be increased in atherosclerotic patients and may have a role in endothelial dysfunction (15). Patients with hypertension have also been observed to have higher levels of IL-6 (17).

Clinical Presentation:

Depending on the underlying etiology and severity of the disease, PRH can show with a wide range of clinical characteristics. Two types of clinical manifestations can be distinguished: acute presentations and chronic presentations (20).

PRH can appear acutely as sudden onset of hypertension, severe headaches, vomiting, epistaxis, or altered mental status. Patients with Takayasu's arteritis, fibromuscular dysplasia, or renal artery thrombosis or embolism frequently present with acute symptoms. Such renal ischemia may result in a sharp increase in renin and angiotensin levels, which would then result in hypertension (20).

PRH can present chronically asymptomatically or more gradually, with symptoms such weariness, malaise, irritability, and a diminished capacity for exercise. Other signs could be pain in the flanks or the stomach, hematuria, or proteinuria. Atherosclerotic renal artery stenosis is frequently linked to chronic manifestations (20).

Particularly in those with an unusual presentation, uncontrolled hypertension despite taking multiple antihypertensive medications, or those who develop hypertension before the age of six years, the presence of hypertension in pediatric patients should raise the suspicion of renovascular hypertension. Furthermore, a renovascular hypertension examination is warranted if a kid with established renal illness exhibits hypertension, particularly in the presence of a reduced glomerular filtration rate or recurrent urinary tract infections (21).

As a secondary consequence of several hereditary diseases, such as neurofibromatosis type 1, Williams syndrome, or Alagille syndrome, PRH can also manifest. In these circumstances, hypertension frequently coexists with additional clinical manifestations of the underlying illness (22).

It can be difficult to diagnose PRH and calls for a high degree of suspicion, especially in the absence of overt clinical symptoms or indications. The patient should undergo a complete physical examination that includes taking their blood pressure in both arms, checking their peripheral pulses, and listening for stomach and renal bruits (23).

A complete blood count, serum electrolytes, creatinine, and an estimated glomerular filtration rate should all be included in the laboratory analysis. The existence of renal parenchymal disease should also be determined through urinalysis and measurement of the urine protein-

to-creatinine ratio. Renovascular hypertension must be diagnosed using imaging procedures such as renal ultrasonography, "*Computed Tomography Angiography* (CTA)", or "*Magnetic Resonance Angiography* (MRA)" (20).

Invasive diagnostic techniques, such as renal arteriography or renal venography, may be required when the diagnosis is still unclear or when a specific etiology is suspected (24).

In conclusion, a high index of suspicion is needed for the early identification and treatment of PRH because it can exhibit a wide range of clinical characteristics. The diagnosis and underlying cause must be established through a complete history and physical examination, as well as the required laboratory and imaging testing. The long-term effects of PRH, such as renal failure, stroke, and cardiovascular disease, must be avoided through early diagnosis and appropriate treatment (23).

Treatment:

A comprehensive strategy is used to treat PRH (25). Controlling blood pressure with antihypertensive drugs, such as ACE inhibitors or ARBs is the first step in therapy. Antihypertensive medications administered intravenously, such as sodium nitroprusside, may be necessary in severe cases (25,26).

Endovascular intervention, such as angioplasty or stent implantation, may be required in situations of renal artery stenosis (24). These procedures come with their own dangers, such as radiation exposure, contrast-induced nephropathy, and restenosis, therefore it is important to choose carefully whether to have them done (24-26).

Surgical revascularization may be an option in some circumstances, particularly when there is bilateral or complicated stenosis (27, 31). Renal replacement therapy, such as hemodialysis or peritoneal dialysis, may also be beneficial for individuals with severe renal artery stenosis and impaired renal function (32).

Overall, pediatric nephrology, interventional radiology, and vascular surgery must work together in a coordinated manner to treat PRH. The objective is to maintain renal function and prevent problems while achieving acceptable blood pressure control (33,34).

Prognosis and Long-Term Outcomes:

The likelihood of developing PRH depends on the severity and prognosis of the condition as well as the presence of any related consequences, including renal impairment or hypertensive encephalopathy. To achieve positive outcomes, early diagnosis and effective care are essential.

Long-term effects for PRH, however, are less clear. In a study of 16 kids with renovascular hypertension who had renal artery stenosis repaired, only 50% did so at a mean follow-up of 5 years, maintaining normotensive blood pressure and normal renal function. Similar rates of renal function decline or recurrence of hypertension have been noted in other investigations, particularly in patients with complicated or bilateral stenosis (33, 34).

Secondary hypertension caused by underlying diseases such fibromuscular dysplasia or Takayasu arteritis, which may call for more vigorous or extended treatment, is one potential indicator of poor long-term results (35). Long-term outcomes may also depend on the degree of renal injury, the severity of renal artery stenosis, and the prevalence of concomitant conditions such diabetes or obesity (34,35).

To monitor renal function, blood pressure regulation, and potential consequences such restenosis or thrombosis, regular follow-up is crucial (12). After renal artery stenosis repair, the American Heart Association advises blood pressure monitoring every 3 to 6 months for at least 2 years, followed by annual monitoring after that (35).

In conclusion, juvenile renovascular hypertension is a rare but significant illness that needs to be identified quickly and managed effectively to have positive results. Early blood pressure management improvements and renal function preservation can be achieved using antihypertensive medicines, endovascular, or surgical treatments. The severity and prognosis of the disease, the existence of concomitant conditions, and the length of the illness may all have an impact on long-term results. To keep track of blood pressure regulation and potential consequences, regular follow-up is crucial.

Conclusion:

Rare but serious PRH can have devastating long-term effects if it is not identified and treated very once. A number of variables, including renal artery stenosis, activation of the RAAS, and oxidative stress, play a role in the pathogenesis of this illness. Early detection and

adequate care, such as antihypertensive drugs, revascularization procedures, and lifestyle changes, can enhance long-term outcomes and avert consequences like cardiovascular disease and chronic renal disease. Maintaining blood pressure management and identifying issues early require close monitoring and follow-up. To manage juvenile renovascular hypertension as effectively as possible, pediatricians, nephrologists, radiologists, and surgeons must work together.

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