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Evolution in the Understanding of the Etiology of Staghorn Renal Lithiasis

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ABSTRACT

Staghorn lithiasis, characterized by renal calculi that extensively occupy the renal collecting system, poses significant medical challenges due to high morbidity and mortality rates. Traditionally attributed primarily to recurrent urinary tract infections caused by urease-producing bacteria, recent studies indicate a shift toward an increased prevalence of metabolic stones. This change may be linked to rising obesity and metabolic syndrome rates. Historical perspectives emphasized struvite stones, associated with infections, but emerging data reveal a notable proportion of calcium phosphate and mixed stones, suggesting a complex interplay between metabolic factors and infection. Analysis of stone composition in patients has shown that metabolic abnormalities are common, emphasizing the need for comprehensive evaluations beyond infectious risk. Understanding this evolving etiology is crucial for guiding treatment and improving patient outcomes.

KEYWORDS: kidney stones, infection, urinary tract, metabolic stones, urinary lithiasis

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INTRODUCTION

Staghorn lithiasis is a subtype of urinary lithiasis, so called because of the morphology adopted by the renal calculi as they occupy most or all of the renal collecting system. It is a disease of great importance from the medical and urological point of view since it involves high morbidity and mortality rates[1]. Several factors are involved in the process of its formation, among which recurrent urinary tract infections caused by uropathogenic urease-producing bacteria that promote an alkaline environment that favors its genesis. For a long time this was considered to be the main factor involved in this phenomenon; however, recent studies have shown that stones caused by metabolic defects are now more common. The reasons responsible for this apparent shift towards a predominance of stones of metabolic origin are still not entirely clear, however, it has been postulated that the increase in the rate of obesity and metabolic syndrome have influenced this development[2].

A Swedish geologist discovered ammonium magnesium phosphate in guano and named it “struvite” after his mentor, the naturalist H.C.G. Von Struve, who first theorized that bacteria split urea, thus establishing the condition for stone formation, and later isolated Proteus vulgaris from a stone. It is now well established that struvite (magnesium ammonium phosphate) stones occur only in association with urinary tract infection by urea-splitting bacteria[3].

Infectious slimes are composed mainly of magnesium ammonium phosphate hexahydrate (struvite) (MgNH4PO4 - 6H2O), but may also contain calcium phosphate in the form of carbonate apatite (Ca10[PO4]6 - CO3)[3].

For a long time, it has been established that struvite makes up the majority of choriform stones, although this configuration of involvement of the collecting system can include any type of stone[3].

Etiology

Staghorn renal calculi are large renal calculi that occupy nearly the entirety of the renal collecting system. They may be composed of metabolic or infection stone types. They are often associated with specific metabolic defects. Infection stones are associated with urease-producing bacterial urinary tract infections[2].

Despite the historical fact that large proportion of staghorn stones are made of struvite, recent reportsrevealed an increasing number of calcium phosphatestaghorn stones, supporting the link between staghornand metabolic stones. Although, to date, thereare no convincing explanations for the shift in staghornstones composition, but it is thought to be secondaryto geographical, dietary, and lifestyle changes[2].

Also, staghorn stones sometimes present as mixedstones – composed of calcium carbonate apatite and stru-vite. This could possibly be explained by the primary ten-dency to form calcium oxalate stones which subsequentlyharbor bacteria triggering the cascade of events leadingto secondary struvite deposition[2].

Staghorn calculi may be of metabolic or infectious origin, and whenever possible it is beneficial to obtain stone analysis data in order to determine this information for guiding treatment and patient counseling. Patient history may also be revealing in this regard[3].

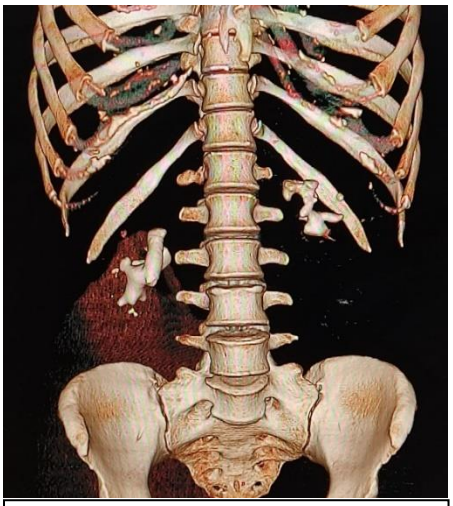
DISCUSSION

The presence of any component of calcium oxalate, uric acid or cystine is indicative of an underlying metabolic abnormality, which is why these stones are commonly referred to as "metabolic" stones[2].

Viprakasit et al. reported on their series of 48 patients with coral stones who underwent percutaneous nephrolithotomy (PCNL) between 2005 and 2010. Of the 52 coraliform stones treated, 29 (56%) were metabolic stones compared with 23 (44%) infection stones. The predominant stone compositions within the metabolic group were calcium phosphate (CaP) 55%, uric acid (UA) 21%, calcium oxalate (CaOx) 14%, and cystine 10%. Thirteen of the 29 (48%) patients with metabolic stones completed 24-hour urine testing and all were noted to have metabolic abnormalities. Other series report similar results[3].

The reasons behind this apparent shift toward a predominance of metabolic stone types in modern series are not entirely clear. It has been postulated that increases in obesity rates over the past few decades could be contributing to the trend as obesity and metabolic syndrome are known to be risk factors for stone formation. Also, this could possibly be explained by the primary tendency to form calcium oxalate stones that subsequently harbor bacteria that trigger the cascade of events leading to secondary struvite deposition[3].

Radiopaque stone that occupies the entire left collecting system. Simple coronal section CT



Bilateral complete staghorn lithiasis. Simple CT with 3D reconstruction

CONCLUSION

Historically, most coraliform stones were believed to be composed of struvite or calcium carbonate apatite because of the general association of these stones with recurrent urinary tract infections and the known association of uropathogenic urease-producing bacteria with struvite formation. In some cases, this dogma influenced decisions to forgo metabolic evaluation in such stone formers, and instead only address infectious risk factors at longitudinal follow-up. However, more contemporary studies have shown that, contrary to long-held belief, stones due to metabolic defects are now more common than stones due to infection.

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