

# Kidney Stone Problem and Ultrasound Imaging- A Study

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**Abstract:** The kidneys are the most powerful organs in our body, and without them, no one can survive their lives. However, many patients suffer from chronic kidney illnesses such as cysts and stones, tumours, infection, and changes in kidney position and appearance. The most common issue is stone formation; even a small stone might bring you to your knees. Renal replacement therapy, such as dialysis or transplantation, is used to treat an increasing number of people with chronic kidney disease (CKD) and end-stage renal failure. As a result, we cannot ignore kidney-related issues because renal failure might put our lives at risk. Hence, early diagnosis and prevention are essential to prevent such renal abnormalities in patients. Ultrasound imaging plays a vital role in recognising kidney-related problems. This paper presents a study about kidney abnormalities and their reorganisation using ultrasound imaging. Recognized information can be useful to detect and locate kidney diseases in their early stages to save the life of a patient.

**Key words:** Kidney, kidney disease, kidney stone, Ultrasound Imaging.

## 1. Introduction

People nowadays are afflicted with various diseases. One of the most common ailments among them is kidney disease, which is on the rise. Chronic kidney disease (CKD) is affecting an increasing number of people around the world. Chronic kidney failure and end-stage renal disease (ESRD) are both progressive conditions that place a significant strain on global health-care resources. Renal replacement therapy—dialysis or transplantation—is used to treat the worldwide increase in individuals with chronic kidney disease (CKD) and end-stage renal failure. Early detection, prevention, and appropriate treatment can help to reduce global stress [1].

A person who has both kidneys damaged can obtain a kidney transplant from an identical kidney donor through renal replacement therapy. Because a medical examination finds that a healthy person with two functioning kidneys can survive with only one kidney, the healthy person can donate one of the kidneys [2]. In addition, people are unaware of the symptoms in the early stages of kidney disease, which can gradually damage the kidneys. Therefore, early detection and prevention are needed to prevent this type of kidney failure in patients. Different diagnostic procedures in medical science, such as ultrasound, MRI, and CT scanning, are available in the present period thanks to advancements in science and technology. All of these methods have advantages and disadvantages when it comes to identifying a particular situation. Apart from that, ultrasound imaging is the first choice of doctors as it is radiation-free and economically cheaper than other techniques [3]. P. Vaish et al. (2016) have developed an android application for B-mode ultrasound images to automatically detect abnormalities in the kidneys. The Viola Jones method was used to discover the main anomalies, which were stones and cysts. Furthermore, texture characteristics were fetched as the system used grey level co-occurrence matrix, intensity histogram features, and grey level run length matrix features to detect these anomalies in the kidney. Moreover, an SVM classifier was used to classify the data [4].

Kidneys are our body's most powerful organs. Nobody would be able to live without them. Kidney and kidney related problems are discussed in detail in section 2. As we are all aware that kidney stone formation has become a widespread problem and cause of

acute pain has discussed in section 3. Apart from that, section 4 explains the role of ultrasound scans and how they can be used to assess kidney size and location, cysts, stones, and other structural disorders. We cannot disregard kidney disorders since kidney failure can put our lives in danger. As a result, it is necessary to diagnose and locate the kidney stone early on in order to successfully complete the surgical procedure to remove the kidney stone.

## 2. Kidney

Human kidneys are the most silent organs in the body. They are a pair of bean-shaped organs on each side of your spine, located below your rib cage, as shown in figure 1. These organs, each about the size of a fist, purify your blood waste and excess water. The waste is primarily composed of dietary components such as calcium that have been broken down. The kidneys convert waste into urine, which is transported to the bladder via tubes (ureters) until it is expelled from the body, as well as maintaining the right balance of beneficial components.[5]

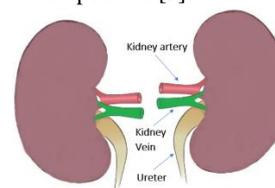


Figure-1 kidney

Kidney functions:

- It helps the body get rid of waste.
- Fluid equilibrium in the body
- They release hormones that regulate blood pressure.
- Drug removal from the body
- Red blood cell production is regulated.
- They create a kind of vitamin D that is active and helps to maintain strong, healthy bones.

### 2.1 Kidney problems

People nowadays are afflicted with a variety of ailments. One of the most common ailments among them is kidney disease, which is on the rise. These illnesses harm the kidneys and endanger the lives of the patients. Some key issues are highlighted, such as



Furthermore, **uric acid stones** occur as a result of obesity and a diet high in animal protein rather than fruits and vegetables. Another form is **struvite/infection stones**, which are rare but huge, have branches, and grow quickly. It is made up of magnesium and ammonia and is induced by a urinary infection. Furthermore, fourth-type stones, also known as **cystine stones**, are extremely rare and are caused by a high level of cystine in the urine. Cysteine is an amino acid in this context. Aside from that, hereditary kidney illnesses, polycystic kidney disease, diabetic nephropathy, kidney infection, and urinary tract infection are some kidney abnormalities [9]. Kidney plays an important role in keeping the human body healthy. Kidney issues should not be ignored as kidney failure can lead to death. The presence of stones or stones in the kidney can result in a variety of problems. Blood in the urine, nausea and vomiting, fever, blockage of the tube connecting the kidney to the bladder, and other side effects are possible.

The author of one of the articles outlined several tips for avoiding kidney stones in children, because Kids' kidney stones cases on the rise even effecting small age kids also [10]. Consuming too much calcium, salt from your food, protein or supplements in your diet but not drinking enough water may raise kidney stone formation risk as well as family history of kidney stones can increase your risk [5]. In one of the articles, the authors have demonstrated that kidney stones are a prevalent clinical issue for doctors. The disease's frequency is rising all over the world. Dietary adjustments, lifestyle changes, and medical management are critical as the affected population grows younger and recurrence rates rise. Patients with recurrent stone disease should be thoroughly examined for a metabolic problem. In all patients with kidney stones, medical therapy should be performed with caution and individualization. Kidney stones are a serious and difficult clinical condition. When used in conjunction with dietary changes, medical therapy can aid in the prevention of recurrence and the ejection of tiny stones. It is vital to understand the benefits and limitations of various medical therapy techniques in order to deliver the best treatment to patients who present with this prevalent complaint [11].

Knowing the type of stone reduces the risk of patients developing more kidney stones since it aids in determining the cause of the stones' creation. As a result, P. M. Arabi et al. (2019) created a novel method for identifying three types of stones: calcium stones, stag horn stones, and others. Furthermore, the task of determining stone type was based on Euler number and pixel intensity matrix contrast [12].

#### 4. Ultrasound imaging

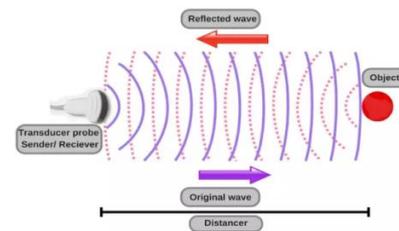
As previously said, ultrasound is a safe, painless, and cost-effective procedure. Ultrasound imaging, ultrasound scanning, and sonography are all terms used to describe ultrasound techniques. Furthermore, an ultrasound scan or image is analysed by a sonographer, cardiologists, radiologists, and other professionals. Apart from that, an ultrasonic scanner is used for this process, which consists of a computer, a tiny transducer, and a video display screen. The transducer, often known as a probe, is a compact hand-held instrument that is connected to the scanner

through a cable [13]. These all components of ultrasound imaging are shown in figure-4.



Figure-4: Ultrasound Machine

Figure-5 depicts a visual illustration of the ultrasonography technique. First, gel is applied to the region of the skin that requires imaging. Then a transducer moves around the skin, taking an inside picture. The probe emits high-frequency sound waves of 1 to 20 megahertz (MHz) into the body through the gel to record interior pictures. These sound waves bounce back and forth, collecting themselves on a transducer and being processed by a computer to generate a picture.[14]



Source:// <https://www.scienceabc.com>[14]

Figure-5: General procedure of ultrasound

The ultrasound method has also been refined and updated as science and technology have progressed. There are three different forms of ultrasound accessible today: 1) traditional ultrasound, 2) three-dimensional ultrasound, and 3) Doppler ultrasound. M. D. Sorensen and J.D. Harper (2013) presented a comparative study to identify kidney stones using colour Doppler twinkling artefact and B-mode ultrasonography. According to this study, the colour Doppler twinkling artefact approach enhanced the sensitivity and specificity of ultrasound. Despite the fact that B-mode was more sensitive, another sparkling artefact was more specific in identifying kidney stones [13].

M. Marsousi et al. (2014) developed a three-dimensional ultrasound system that can automatically recognize and segment kidneys in 3-D abdominal ultrasound image. The suggested system uses a probabilistic kidney shape model for detection and segmentation procedures. This research proposes an automated kidney identification approach based on 3-D Morison's pouch ultrasound image. Furthermore, the identified kidney was segmented using a shape-based technique. Furthermore, finite impulse response filters and Hamming windows were employed to overcome the difficulties of speckle noise and inhomogeneous intensity [15].

Ultrasound is broadly used technique to find abnormalities in kidney as comparison to other technologies. Because it is safe, radiation free, painless and economical. There are some advantages of ultrasound imaging as it is used to check the presence of the stone and cyst. Moreover, used to distinguish the

abnormalities, find out the blockage of urine flow etc. Ultrasound examination has a specific place in urology. Compared to other techniques, ultrasound is a commonly used tool to detect abnormalities in the kidneys. Because it is safe, painless and cost effective. Ultrasound imaging has some advantages as it is used to detect the presence of stones and cysts. It's also used to detect irregularities, determine if urine flow is blocked, and so on. In the urinary tract, ultrasound examination has a special place. It is commonly performed on-call by urologists and is used as a first-line imaging evaluation in the vast majority of patients. As a result, it is a required skill for the urology major. Ultrasound imaging is used for more than just diagnostic purposes. Although expertise and understanding in the field of the core subject differ, ultrasound tests done by a urologist and a radiologist should fulfil the same requirements. Being the derivative of those factors, it has a considerable bearing on examination interpretation. Ultrasonography could be used to diagnose and treat serious kidney disease, the researchers measured kidney volume, which measures the actual size of the kidneys, and, in fact, chronic kidney disease [16].

**Limitations of ultrasound images:** However, ultrasound imaging plays an important role as the first method of detecting and detecting kidney stones. In addition to its low cost and the fact that it is widely used due to its non-radioactive, safe and easy to use. During surgical procedures, it is also important to determine the exact location and location of the kidney stones. As a result, more image quality is required to produce related features. However, adding noise to these images, as well as low contrast and other defects, can lead to a variety of factors. Furthermore, there are three different sorts of noises: (a) Impulsive noise is caused by data transmission errors, memory location issues, or digitization timing errors; (b) additive noise (Gaussian noise) is caused by electronic noise in the image acquisition system; and (c) multiplicative noise (speckle) is unsystematic in nature and is the main issue in ultrasound images. Essential aspects should not be compromised by the right balance of noise reduction and image quality enhancement [17].

## 5. Conclusion

A healthy life is a happy life—every person wants to live a long and healthy life. However, people are suffering from various diseases, and kidney diseases are one of the major diseases amongst them, which are increasing day by day. In this paper, the role of the kidney in our lives, kidney functions, and kidney abnormalities are discussed. Moreover, it focused on a very common problem, kidney stone formation, which has become a serious and challenging clinical problem as well as stone formation regions and its cure. To detect and recover kidney abnormalities, commonly used techniques to diagnose kidney abnormalities, ultrasound imaging has been discussed. Despite the fact that ultrasound imaging is the primary choice of physicians because it is radiation-free and less expensive than other techniques.

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