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THE HISTORY OF UROLITHIASIS

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BY
M. BRITEL REDA
Born on the 16th April 1999 in Fez

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JURY

M. BENJELLOUN ELBACHIR ..... PRESIDENT
Professor of General Surgery

M. KHALLOUK ABDELHAK..... REPORTER
Professor of Urology in Tangier Medical Faculty

M. KHARBACH YOUSSEF..... JUDGES
Professor of Urology in Tangier Medical Faculty

M. MELLAS SOUFIANE .....
Professor of Anatomy

M. RETAL YOUSSEF..... Associated member
Assistant Professor of Urology in Tangier Medical Faculty

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ABBREVIATIONS

3D : Three Dimensional

CT : Computerized Tomography

CaSR : Calcium Sensing Receptor

EHL : Electro Hydraulic Lithotripsy

ESWL : Extracorporeal Shock Wave Lithotripsy

NSAIDs : Non-Steroidal Anti-Inflammatory Drugs

PCNL : Percutaneous Nephrolithotomy

YAG : Yttrium Aluminum Garnet

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INTRODUCTION

Urolithiasis, the medical term for the formation of stones or calculi in the urinary tract, is a disease that has plagued humanity for millennia. This condition can lead to significant morbidity, characterized by episodes of severe pain or colic, urinary obstruction, and to its potentially fatal complications such as infections or renal failure, thus representing a significant health concern across various demographics. The historical significance of urolithiasis is underscored by its prevalence across diverse cultures and epochs, making it a prominent focus of medical inquiry throughout history. Furthermore, its long and painful history dates back to the dawn of civilization, the earliest references to urinary stones are mentioned in ancient Mesopotamian and Egyptian medical texts and the first bladder stone was discovered in a mummy dating back approximately 7000 years.

The exploration of urolithiasis extends far beyond contemporary medical practice; it encompasses a rich tapestry of historical knowledge, cultural beliefs, and evolving scientific understanding. The journey from ancient remedies and rudimentary surgical techniques to modern minimally invasive procedures illustrates a remarkable trajectory of medical progress.

This literature review aims to provide a comprehensive overview of urolithiasis through various historical lenses. The study will begin by tracing ancient civilizations' contributions, including the Mesopotamians, Egyptians, Greeks, and Romans, who laid the groundwork for a primitive medical approach and an early understanding of the condition. The medieval period will be explored next, particularly focusing on the contributions of Islamic scholars during the Golden Age of Science, whose advancements in medical understanding and surgical techniques influenced practitioners for centuries to come.

As the Renaissance ushered in a new era of anatomical discovery and empirical investigation, we will investigate the emergence of urology as a distinct medical specialty, marked by key figures and innovations that shaped surgical techniques and diagnostic approaches.

The 19th and 20th centuries heralded a new era in urology with the introduction of advanced surgical methods and technologies.

Finally, the thesis will conclude with a discussion of contemporary research and innovations, including the latest advancements in minimally invasive procedures and personalized medicine.

In summary, this thesis not only aims to analyze how civilizations understood and treated urolithiasis, highlighting significant medical texts and cultural beliefs that influenced their approaches, but also to foster a deeper understanding of its implications for current medical practices. As we navigate this intricate history, we will reveal the complexities of urolithiasis management, shedding light on how past knowledge informs contemporary approaches and future innovations.

ANCIENT TIMES

I. Mesopotamia (c.3000 – 539 BCE)

Ancient Mesopotamia is a historical region, etymologically formed from the Greek *"meso"* meaning between and *"potamos"* meaning river, effectively situated within the Tigris-Euphrates river system, is recognized to be the cradle of some of the earliest civilizations in human history.

Comprising several powerful city-states such as Sumer, Akkad, Babylon, and Assyria, Mesopotamia was a center for early developments in writing which took humanity from prehistory to recorded history, astronomy and most of all medicine.

This chapter, through analysis of the ancient Mesopotamian medical corpus explores the contributions of Mesopotamian medicine to the early understanding of urolithiasis, examining how this condition was diagnosed, treated, and perceived within the cultural context of the time.

1. Historical context and medical vista

In Mesopotamia, medicine was deeply intertwined with religious and spiritual beliefs. Illnesses were often viewed as punishments from gods or the result of demonic influences, leading to a medical practice that emphasized both supernatural and naturalistic explanations. Mesopotamian healers included two primary groups: the *āšipu*, translated to exorcist-healers, who focused on spiritual remedies, and the *asû*, or empirical healers, who used herbal remedies and rudimentary surgical practices. The distinction between these two roles reflects the multifaceted nature of Mesopotamian medicine, where treating physical symptoms and appeasing spiritual forces were often inseparable[1].

Diagnosing illnesses in Mesopotamia was a complex process involving both empirical observation and divination. Healers would observe the physical symptoms exhibited by patients and interpret them through a combination of their empirical knowledge and supernatural beliefs. Furthermore, healers often conducted rituals or consulted omens to determine whether an illness was a result of supernatural interference[2].

2. Key sources

- *The Diagnostic Handbook:* often referred to as the Diagnostic Series or SA.GIG, is a comprehensive collection of medical texts that focuses on diagnosing diseases based on observed symptoms and consists of around 40 clay tablets organized into sections that cover various ailments, systematically arranged in a head-to-foot order **(Fig. 1)**. It was compiled during the Neo-Assyrian period, primarily under the Babylonian king Adad-apla-iddina (1068-1047 BCE) by the scholar Esagil-kīn-apli. It contains some of the clearest references to urolithiasis symptoms[3].
- *The Nippur Tablets:* Discovered in the ancient city of Nippur, these tablets date from around 2000 BCE and are among the earliest records of medical practices in Mesopotamia[4].
- *The Cuneiform Tablets from the Library of Ashurbanipal:* The library of the Assyrian king Ashurbanipal (7th century BCE) in Nineveh held thousands of cuneiform tablets, including medical texts[5].

- *The Sakikkū Texts:* These texts are a compilation of omens and diagnoses used for divination, often closely associated with health issues including urinary and abdominal pain and treatment that consisted of incantations mixed with practical remedies[6].

Figure 1. Neo-Assyrian medical tablet dealing notably with disorders of the kidney[1].

3. References to urinary disease and urolithiasis:

Even if the disease is believed not to have been fully understood, Mesopotamian physicians showed skill in observing and documenting symptoms. Their understanding of urolithiasis symptoms would have been based primarily on patients' descriptions. Symptoms were carefully noted and compared with previous cases, which healers recorded on cuneiform tablets.

Tablets often refer to specific ailments associated with urinary discomfort, which might include:

- **"Sand in the Urine"**: One of the notable mentions of urological symptoms comes from the Nippur Tablets, where healers describe the presence of granules in the urine, indicating an early observation of crystalline sediment possibly caused by kidney stones.
- **Abdominal Pain and Flank Discomfort**: Descriptions of acute pain in the lower back or abdomen are common and closely match the painful symptoms of urolithiasis.
- **Difficulty Urinating**: Some tablets mention blockages in the urinary tract, likely related to kidney stones or other obstructions.

The following selection is an attempt to identify certain manifestations of renal disease and related symptoms in cuneiform tablets:

- *"If a man has pain in the 'flesh' of his kidney, his hips (or groin) are affected and his urine is white like donkey urine, and later on his urine contains blood, that man suffers from 'discharge' (mu-disease), you boil together 2 shekels of myrrh, 2 shekels of baluhhu, 2 sila-measures of grape juice in a jug; cool it and mix it (in*

two parts) equally in pressed oil. You pour half of (the mixture) into his urethra through a bronze tube; the other half mix in best beer and let it sit out [overnight] and give it to him to drink on an empty stomach and he will get better.[1]*"*

Here in this passage of *The Diagnostic Handbook*, translated by M.J. Geller, one can see three stages of good medical practice, namely observation of pain in the kidney, investigation of the colour of the urine, and noting that it contains blood, followed by treatment. **Mu-disease or musu-disease**, often referred to in the context of ancient Mesopotamian medical texts, specifically relates to a condition characterized by symptoms associated with urinary issues, particularly urolithiasis. The term "musu" itself is derived from Sumerian and is often interpreted as "stone" or "rock"[1].

- *"If a man suffers from pain in his lower abdomen, like burning fire, and his urine flows slowly, in small drops, mixed with stony particles, his life-force weakens, and he feels afflicted. To cure him, let him pour juniper and pine resin in a cup of beer and drink it at sunrise. To the god Enki, he shall offer a sacrifice, for it is Enki who controls the waters of the body."*

In this excerpt from the *Nippur Tablets*, the descriptions align with kidney stone symptoms, particularly slow and painful urination accompanied by “stony particles.” Enki (or Ea), the god of wisdom, magic, and water, was frequently invoked in medical rituals involving water-related ailments, including urinary issues[4].

- *If a man feels burning and sharp pains in his sides and belly, and his urine does not flow easily, this is the sign of a demon binding his waters. To relieve him, make an offering to Gula (goddess of healing) and bind a charm of juniper wood on his left hand. Recite the following incantation: 'Demon of blockage, leave this man's body! As the waters flow freely from the mountains, let his waters be free.'"*

This sample passage from the *Sakikkū Texts*, describes symptoms like burning and sharp abdominal pain and urinary obstruction, resembling

urolithiasis. Here, the affliction is attributed to a "demon" or spiritual blockage. The treatment includes a charm, incantations, and invoking the goddess Gula, specifically known as the goddess of healing and medicine, blending empirical remedies with spiritual beliefs to address what they saw as a supernatural cause of kidney stone symptoms, stressing once again the duality in their medical approach[6].

4. Treatment practices:

The most common type of Babylonian medical text consists of prescriptions in which descriptions of symptoms are immediately followed by extensive recipes, there are some incantations within the medical corpus, but these are of relatively minor importance in relation to the recipes, which embody the main purpose of the medical texts. The texts were probably written by the *asû*, the so-called 'physician' whose function was closer to that of a pharmacist. It seems likely that it was the incantation-priest who visited the patient to offer a diagnosis, while the physician/pharmacist was the

technician who actually made up the recipes as the opening line from *The Diagnostic Handbook* suggests: *'when the āšipu goes to the house of the sick man'* [1].

Indeed, the visit allowed the *āšipu* to examine the patient and gather detailed information about their symptoms. He was then tasked with making a diagnosis based on direct observation of the patient's condition and environment, as well as a prognosis function consisting of predicting the patient's future health outcomes, which was vital for both the patient and their family, providing them with insight into what to expect. After diagnosing the ailment, the āšipu could decide on a course of action that might include reciting incantations, performing rituals, or referring the patient to an **asû** (physician) for more conventional medical treatments[3].

a. **Herbal Remedies and Treatments:**

The prescriptions consisted of many different plant and mineral ingredients, often boiled or distilled in solvents as wine or beer, which were ingested through the mouth or rectum in the form of potions, pills, or suppositories[1].

Here are some examples of the most common prescriptions:

- **Juniper Berries**: Juniper was commonly prescribed for conditions involving the urinary tract due to its diuretic properties. Preparations often included crushed juniper berries mixed with barley water or beer, creating a mildly diuretic mixture to help alleviate the symptoms of urinary stones. Apart from its medicinal properties, juniper held symbolic significance; It was often associated with purification and protection against evil spirits[6].

- **Yarrow (*Achillea millefolium*)**: It was believed to relieve inflammation and promote urination, potentially helping to expel stones[7].
- **Beer and Barley Mixtures**: The Mesopotamians frequently combined herbs with beer or barley water, possibly to facilitate hydration or create a palatable remedy. These beverages likely helped to encourage urination, aiding in the passage of stones[6].

b. Dietary measures and hydration:

Although formal lifestyle recommendations are rare in Mesopotamian texts, certain practices implied an understanding of hydration's role in urinary health.

One of the foundational aspects of lifestyle recommendations for urinary health in Mesopotamian medicine was a focus on hydration. While today's medical understanding confirms the importance of hydration in preventing kidney stones, Mesopotamians recognized this connection on an intuitive level, advising patients with symptoms of urolithiasis to consume increased fluids mainly as a preventive method[8].

The ancient Mesopotamians understood that certain foods could exacerbate or alleviate symptoms of kidney stones, though their understanding was largely based on observation and experience rather than scientific analysis. The medical texts of the time often recommended dietary changes as a primary means of managing urolithiasis. These dietary prescriptions included the avoidance of foods that were thought to be too "heavy" or likely to cause internal imbalances, which might predispose individuals to the formation of kidney stones[9].

c. Surgical procedures:

The “Diagnostic Handbook” mentions the practice of inserting a "surgical instrument" into the bladder to either remove or break apart stones, a method akin to the lithotripsy techniques that would later be developed in ancient Greece and Rome[10].

However, these procedures were not always successful, and they carried a significant risk of infection due to the lack of sterile techniques and anesthesia. Mesopotamian records also suggest that the outcomes of such operations were often uncertain, and it is likely that many patients, especially those with larger stones, suffered from complications or death due to the invasiveness and risks associated with surgery[7].

d. Spiritual and ritualistic healing:

- **Incantations and Prayers to Deities**: Gods like Ea (Enki), the god of water and wisdom, and Gula, the goddess of healing, were frequently invoked. Incantations were recited to ask these deities to “clear the pathways” and remove the harmful forces within the body[9].
- **Charms and Amulets**: Amulets were tied to patients’ bodies, particularly made of juniper wood, which was believed to protect against the spirits causing the blockage. This practice symbolized the physical and spiritual removal of obstructions[6].
- **Sacrificial Offerings**: Offerings were made to gods, such as the sacrifice of animals or food items, to appease deities like Enki and Gula. In some treatments, a small animal was sacrificed, and its spirit was asked to carry away the illness, a practice intended to transfer the affliction from the person to the sacrificial entity[3].

5. Posterity:

Mesopotamian treatments for urolithiasis left a significant legacy that would influence future cultures. Indeed, the practice of recording medical knowledge on cuneiform tablets, influenced the way later civilizations documented and preserved medical knowledge. This tradition of written records enabled continuity and knowledge transfer across generations and borders.

This recorded medical knowledge that spread through trade routes, diplomatic exchanges, and the movement of scholars and consisting mainly of diagnostic methods, herbal practices, notably the use of diuretics like juniper and the holistic approach to health—which considered both physical symptoms and spiritual factors appeared in Egyptian medicine, as seen in the Ebers Papyrus, and was later adopted and refined by Greek physicians like Hippocrates, who began moving toward a more secular understanding of disease[8].

Mesopotamian urolithiasis treatments continue to resonate in modern approaches to kidney health, particularly in the use of preventive hydration, diuretic herbs and non-invasive techniques: modern healthcare often favors non-surgical approaches, reserving surgery for severe cases. This principle of minimizing invasiveness indeed reflects a continuity of Mesopotamian practices in modern urology.

II. Ancient Egypt (c.3100 – 30 BCE)

Ancient Egypt, one of the most remarkable civilizations in human history, thrived along the Nile River from approximately 3100 BCE to 30 BCE. Known for its monumental achievements in architecture, agriculture, and governance, Ancient Egypt also made substantial contributions to early science and medicine. Although limited by the scientific knowledge and technology of the time, Egyptian physicians developed an early understanding of urinary ailments, employing herbal remedies, dietary guidelines, and spiritual rituals to treat symptoms associated with urolithiasis.

This chapter aims to explore the historical context of urolithiasis in Ancient Egypt, through analyzing archaeological evidence, ancient medical texts, and cultural beliefs surrounding health and disease.

1. Archaeological evidence of urolithiasis in Ancient Egypt

One of the oldest documented cases of urolithiasis, identified as a bladder stone, was found in the remains of a young male mummy, dating back to around 4800–4500 BCE **(Fig. 2).** The stone, located in the pelvic region of the mummified body, was composed primarily of calcium oxalate, suggesting that the environmental and dietary conditions at the time contributed to the formation of urinary calculi[11].

The discovery of these stones in mummies predating written records shows that urolithiasis had been a health concern since the earliest stages of Egyptian civilization. The Predynastic evidence suggests that the combination of high temperatures, common dehydration, and dietary factors (such as reliance on grains that are rich in oxalates) might have contributed to the development of urinary stone[11].

Figure 2. Picture of the oldest bladder stone ever discovered, by the British Virtual Museum.

2. Medical texts and descriptions of urolithiasis

Ancient Egyptian medical texts, particularly the Ebers and Kahun Papyri, provide some of the earliest recorded descriptions of urinary ailments that align with the symptoms of urolithiasis. Although specific terms for "urolithiasis" or "urinary stones" are absent, the descriptions in these papyri suggest a familiarity with symptoms consistent with urinary tract disorders, such as pain during urination and abdominal discomfort.

a. The Ebers Papyrus (circa 1550 BCE):

The Ebers Papyrus is one of the longest and most complete ancient Egyptian medical texts, measuring over 20 meters in length. Written in hieratic script, it is divided into sections that address a broad spectrum of diseases, from internal medicine to dermatology, dentistry, gynecology, and notably urology. The papyrus's structure organizes ailments by bodily systems, and several sections focus on diseases of the abdomen and urinary tract **(Fig. 3)** [12].

Descriptions of "gravel" or "sand" in the urine appear several times, possibly as a lay explanation of the appearance of small stones or crystals in the urine. Ghalioungui (1973) points to these terms as indirect indicators of urolithiasis, suggesting that Egyptian physicians were familiar with the painful symptoms and the characteristic discharge of urinary stones, even if they did not fully understand the underlying pathology[12].

One notable section describes symptoms such as intense abdominal and flank pain, frequent urination, and difficulty in passing urine—symptoms that correspond with both kidney and bladder stones. Egyptian healers may not have differentiated between types of urinary stones but likely grouped these symptoms under a general category of abdominal or pelvic pain[12].

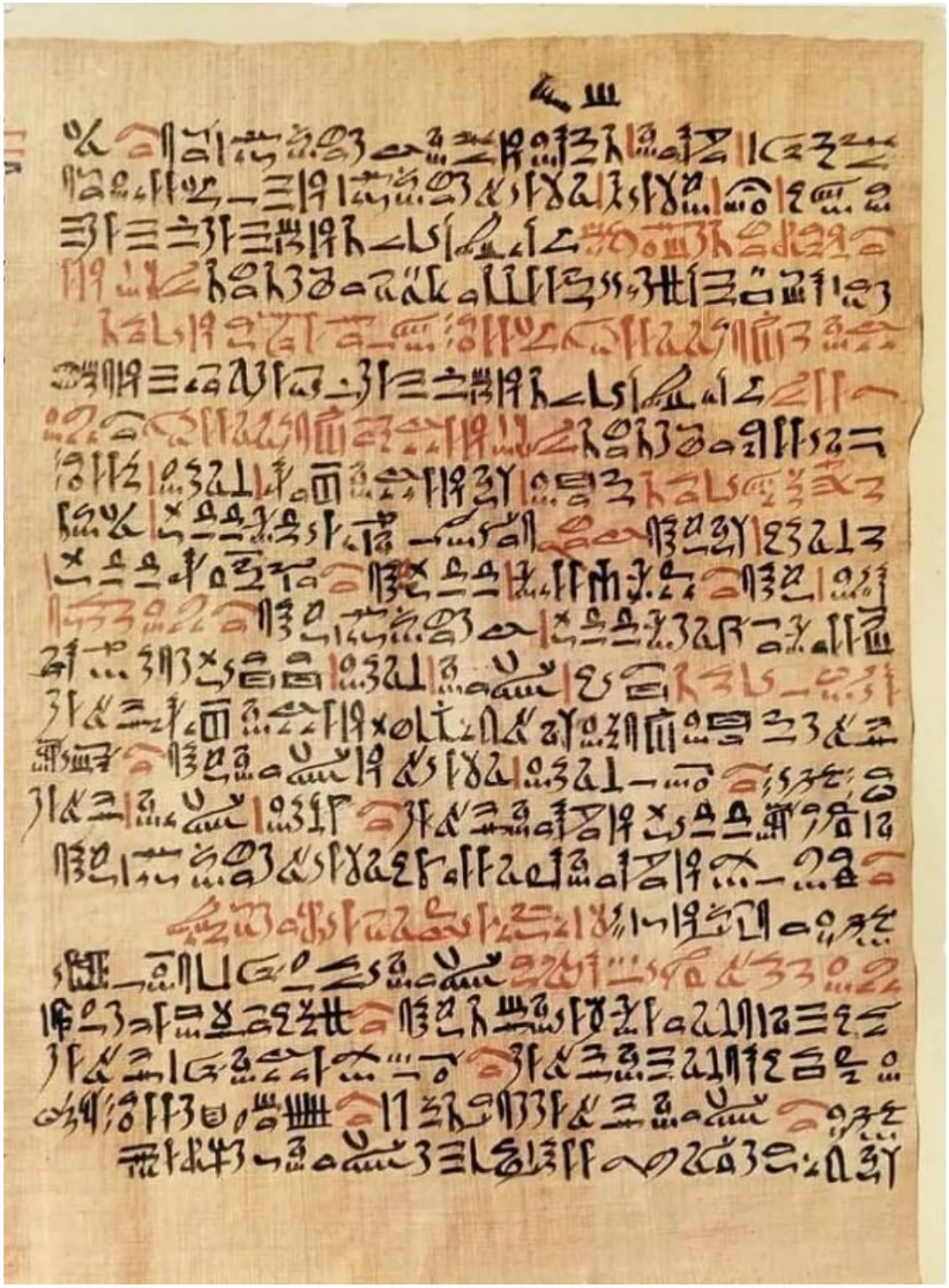

Figure 3. A passage from the Ebers Papyrus, circa 1550 BCE

b. The Kahun Papyrus (circa 1825 BCE):

The Kahun Papyrus, one of the earliest surviving Egyptian medical documents, is primarily a gynecological text but also includes sections that refer to ailments of the urinary system. Although it does not directly describe urinary stones, it contains descriptions of symptoms such as abdominal pain and urinary difficulty, which may relate to what we now recognize as symptoms of urolithiasis. Nunn (1996) interprets these references as potentially indicating a rudimentary understanding of urinary tract discomfort or blockage, conditions that could have been associated with stones[13].

The Kahun Papyrus, like the Ebers Papyrus, often treats disease with a combination of herbal remedies and incantations. This text reflects the Egyptian approach of integrating physical treatments with spiritual and ritualistic elements, especially when addressing diseases thought to be caused by supernatural influences. This blend of physical and metaphysical treatment indicates that ancient Egyptian healers sought to manage both the physical symptoms and the perceived spiritual causes of diseases, which they may have believed could exacerbate conditions like urolithiasis[13].

c. The Edwin Smith Papyrus (circa 1600 BCE):

The Edwin Smith Papyrus, while primarily a surgical text, also contains references to abdominal and pelvic pain that could suggest conditions involving urinary organs. This papyrus is significant for its more analytical approach to disease and injury, describing cases and treatments in a methodical manner. It represents one of the earliest systematic medical texts and indicates descriptions of painful urination and the recommendation for local applications that may reflect attempts to manage urological pain, though

it is less explicit than the Ebers Papyrus in this regard[14].

3. Environmental and dietary influences on urolithiasis

A panel of factors indicate that urolithiasis was a fairly prevalent disease in Ancient Egypt, we'll analyze in this following chapter the most eminent of these factors.

a. Dietary factors

- **Vegetarian diet**: Ancient Egypt played a major role in the transition that humanity witnessed from a hunter-gatherer to a sedentary agricultural lifestyle, relying on plant-based diets, which may have offered protective effects against certain types of stones but increased risks for others, depending on oxalate content[15].

- **Protein and Salt Intake**: Meat, almost exclusively consumed in the upper echelons of society, was a source of purines that could lead to uric acid stones. The heavy use of salt in food preservation, notably for fish and meats, may have contributed to the formation of uric acid stones by increasing urinary concentration[8].

- **High-Calcium Diet**: The Egyptian diet was rich in calcium due to staples like bread and beer made from wheat and barley, which are high in calcium oxalate. This dietary composition likely contributed to stone formation[16].

b. Climate and hydration

Egypt's arid climate made dehydration a common issue, predisposing individuals to concentrated urine and the subsequent formation of stones. While the Nile River provided water for irrigation and daily use, the distribution of water throughout ancient Egyptian society may have been

uneven. Limited access to fresh drinkable water in certain regions compounded the problem, especially for laborers and lower socioeconomic classes[17].

4. Treatment approaches:

a. Pharmacological interventions:

The Ancient Egyptians relied on natural substances to treat urolithiasis. The recipes preserved in medical texts like the *Ebers Papyrus* illustrate their empirical knowledge of diuretic and anti-inflammatory plants. Here are some examples of the most commonly used:

- **Coriander (*Coriandrum sativum*)**: Coriander seeds were crushed and consumed as a tea or mixed into pastes to alleviate bladder pain and inflammation[13].

- **Cumin (*Cuminum cyminum*)**: Most likely used to reduce inflammation and urinary discomfort[13].

- **Aloe vera**: Renowned for its ability to soothe irritated tissues and reduce inflammation, Egyptians likely used it in the form of a poultice or as a part of a medicinal drink to reduce the inflammation in the urinary system caused by stones[15].

Not only that, but the *Ebers Papyrus* reflects a sophisticated approach to combining ingredients. Notably, a remedy for urinary difficulties involved mixing barley flour with beer to create a drink designed to dissolve obstructions[18]. Another example is the use of preparations involving milk, honey, and plant-based oils as they were prescribed for abdominal and urinary discomfort[13].

b. Surgical tools and procedures

Unlike later Greek and Roman physicians, there is no direct evidence that Egyptians performed lithotomy. However, their anatomical knowledge, as reflected in the *Edwin Smith Papyrus,* suggests an understanding of the urinary system's structure and potential pathologies[18].

Moreover, their approach focused on alleviating symptoms caused by blockages. Thin, hollowed-out reeds or papyrus stems were used as urinary catheters to bypass obstructions in the bladder or urethra. The use of these catheters, described in medical texts like the *Ebers Papyrus*, involved inserting the device into the urethra to drain accumulated urine. This method alleviated pressure and pain, which were likely caused by the inability to pass stones naturally[13].

c. Spiritual dimension

Not unlike the Mesopotamians, the line between medicine and religion was blurred in ancient Egypt, and healing practices often included magical elements. Urolithiasis was not only a physical ailment but also a spiritual imbalance requiring divine intervention. Sekhmet, the goddess of healing and war was invoked in prayers and rituals for severe illnesses and pain relief. Physicians might offer sacrifices or recite incantations to gain her favor. Thoth,

the deity of wisdom and medicine, was believed to guide physicians in their treatments, ensuring success in their efforts **(Fig. 4)** [13].

Stones were often referred to as demonic beings obstructing the urinary tract. Incantations sought to “convince” the stones to dissolve or pass painlessly. The *Ebers Papyrus* includes spells directed at urinary stones, personifying them as malevolent entities. A common spell implored the stone to “dissolve like dew under the morning sun,” reflecting the Egyptians’ belief in the power of words and intentions[18].

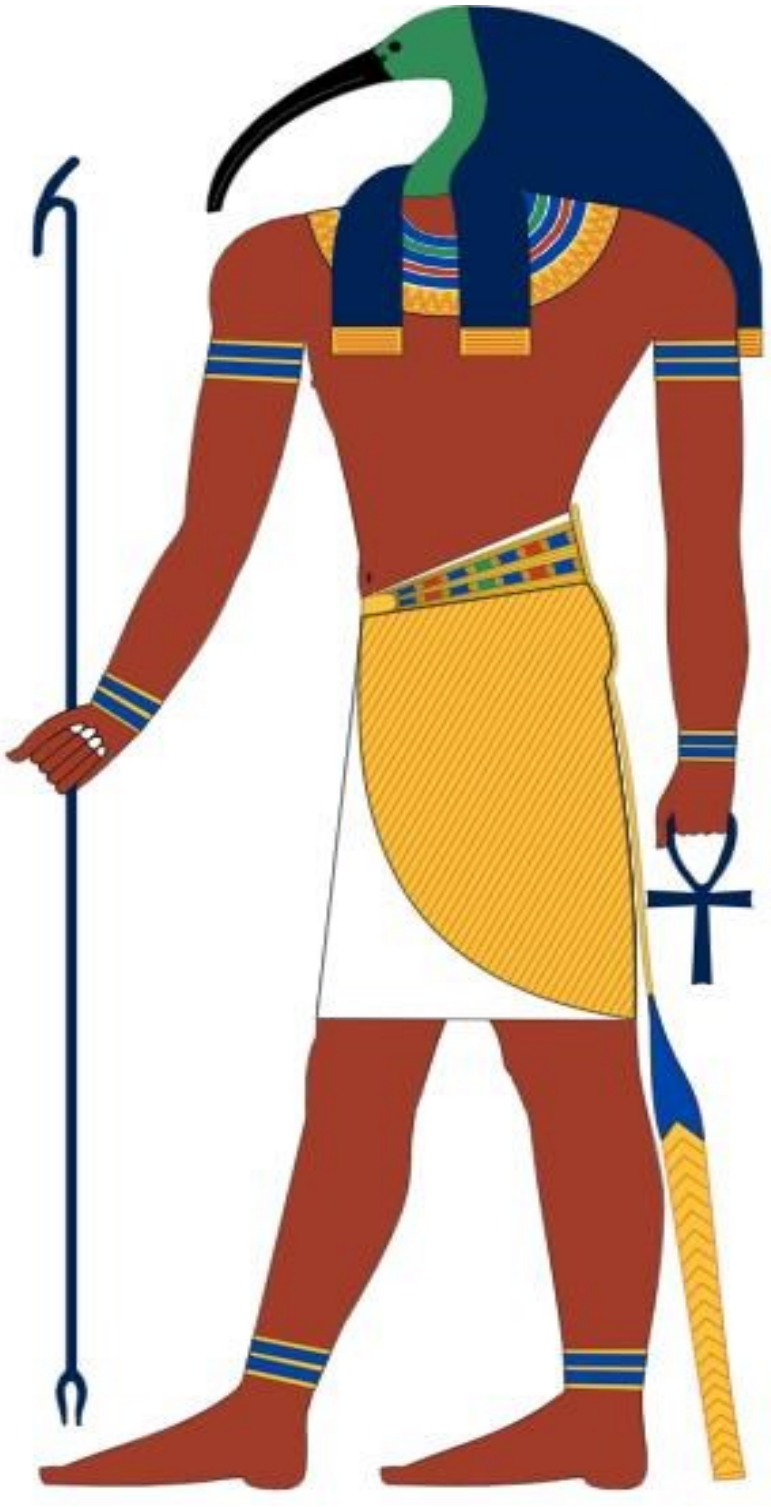

Figure 4. Representation of Thoth, the god of wisdom, writing, and medicine [19]

III. Ayurvedic medicine (Ancient India)

The term *āyurveda* in Sanskrit is composed of two words: *āyus* meaning "life" or "longevity" and *veda* meaning "knowledge" thus translating to "knowledge of life and longevity". It is one of the oldest holistic healing systems, originating in India over 5,000 years ago and pioneered by renowned practitioners, notably Sushruta (**Fig. 5).**

The backbone of Ayurveda are ancient texts divided into two primary categories known as the Brihat Treya (the three great texts) and the Laghu Treya (the three lesser texts). Urolithiasis, referred to as Mutrashmari (Mutra= urine, Ashmari = stone), was extensively documented in Ayurvedic literature, primarily in the *Sushruta Samhita* **(Fig. 6)** and the *Charaka Samhita* (two of the three great texts).

Figure 5. Statue representing the father of surgery Sushruta, located in Patanjali Yogpeeth, Haridwar [20].

1. Conceptual framework:

In Ayurveda, health depends on the balance of the three doshas: Vata, Pitta, and Kapha. Each representing a unique combination of elements that conditions one's physical, mental and emotional characteristics:

- **Vata** usually represents Air and Space, it governs movement and communication in the body, including circulation, breathing, and elimination.
- **Pitta** represents Fire and Water; it controls transformation processes in the body and is responsible for energy production.
- **Kapha** stands for Water and Earth, it provides structure and stability to the body and governs bodily fluids and lubrication.

Mutrashmari arises from an imbalance in these doshas, particularly when aggravated Kapha interacts with Vata or Pitta to precipitate urinary sediments into stones. Kapha's heaviness and stickiness contribute to stone formation, while Vata's dryness causes sediment to harden, and Pitta aggravates inflammation and pain. This pathophysiology underpins all Ayurvedic treatments for urolithiasis[21], [22].

2. Diagnostic approach and classification of Mutrashmari

Ayurvedic practitioners, relied on symptoms like painful urination, hematuria, and abdominal discomfort to diagnose Mutrashmari. Urine color and flow patterns were key diagnostic indicators. It is also believed that urine was analyzed for sediment, color, and odor to identify the predominant dosha and type of stone. Foaminess indicated Kapha involvement, while a burning sensation suggested Pitta[21].

Sushruta goes as far as elaborating a classification of Mutrashmari in *Sushruta Samhita*, thus distinguishing four types based on the dominant dosha involved:

Type of stone	Characteristics	Associated symptoms	Suggested treatment
Vataja Ashmari (Vata-type stone)	Small, hard, and rough	Severe pain in the bladder and abdomen, difficulty passing urine	Pacification of Vata dosha with warming, lubricating remedies
Pittaja Ashmari (Pitta-type stone)	Yellow or reddish, sharp-edged	Burning sensation, reddish or yellowish urine, frequent urination with pain	Cooling herbs and a Pitta-pacifying diet
Kaphaja Ashmari (Kapha-type stone)	Large, smooth, and white	Dull pain, sluggish urination, heaviness in the bladder	Cleansing and Kapha-reducing remedies
Shukraja Ashmari (Sperm-related stone)	Less frequently mentioned, caused by seminal fluid (Shukra) disorders	Pain in the lower abdomen and difficulty in urination	Specific cleansing therapies and dietary adjustments

Table 1. Classifying the different types of stone per the Sushruta Samhita [22], [23].

3. Therapeutic modalities:

Ayurveda emphasizes a combination of preventive, medicinal, and surgical approaches to treat Mutrashmari.

a. Dietary and lifestyle adjustments:

Regular physical activity and avoiding sedentary behavior were emphasized to maintain urinary flow and metabolic health.

Moreover, patients were likely encouraged to consume hydrating foods, like barley water, cucumber, and coconut water, while avoiding spicy, sour, or salty foods[21].

b. Herbal treatment:

A panoply of plants and herbs with litholytic and diuretic properties were recommended, eminently Varuna (*Crataeva nurvala*), a plant used in infusion that dissolves stones and tones the urinary tract to prevent recurrence[21], or Kulatha (*Dolichos biflorus,* horse gram), a dietary inclusion used as soup to break down stones to name just a few [22].

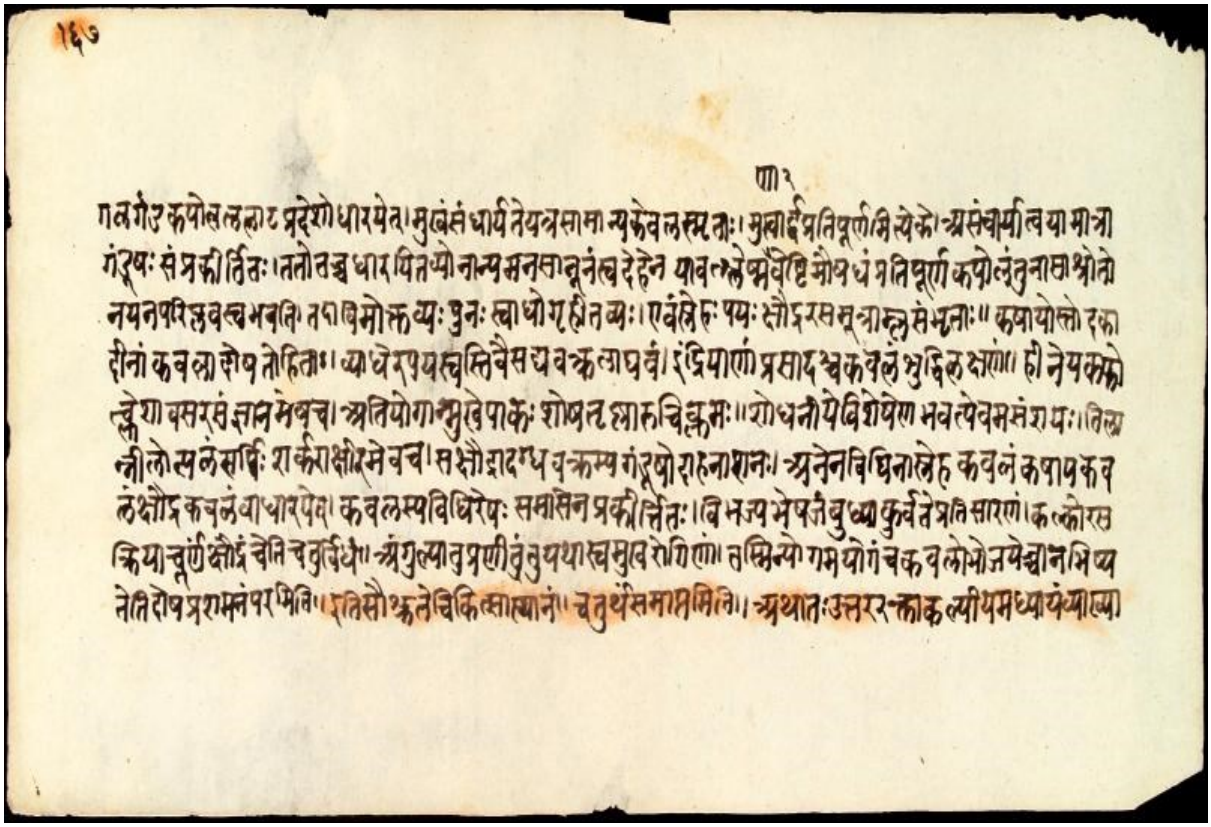

Figure 6. A page from the ancient medical text, Sushruta Samhita.

c. Surgical treatment:

Many medical treatments were recommended for stone sufferers in ancient India: a vegetarian diet, a urethral syringe of medicated milk, clarified butter, or alkalis. Only when these treatments failed was surgery used[24].

Sushruta was one of the first to describe lithotomy in great detail. He listed preoperative preparations to include anointing the body, cleansing of the system with emetics and purgatives, and prayers and offerings to the gods. He then proceeded to detail the position of the patient who '*lies on his back, placing the upper part of the body in the attendant's lap, with his waist resting on an elevated cloth cushion … knees and elbows contracted and bound*' **(Fig. 7).** The attendant is described as a person of '*strong physique and unagitated mind'*. The surgeon then rubs clarified butter into the left side of the umbilical region and '*presses firmly with his fist downwards until the stone is as low as possible*'[24].

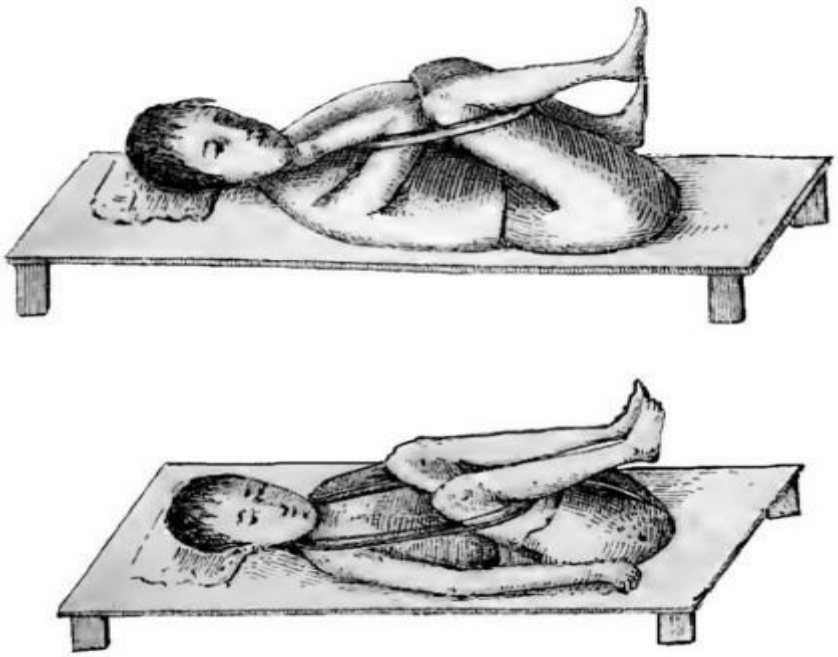

Figure 7. Two methods of lithotomic position recommended by Sushruta [25].

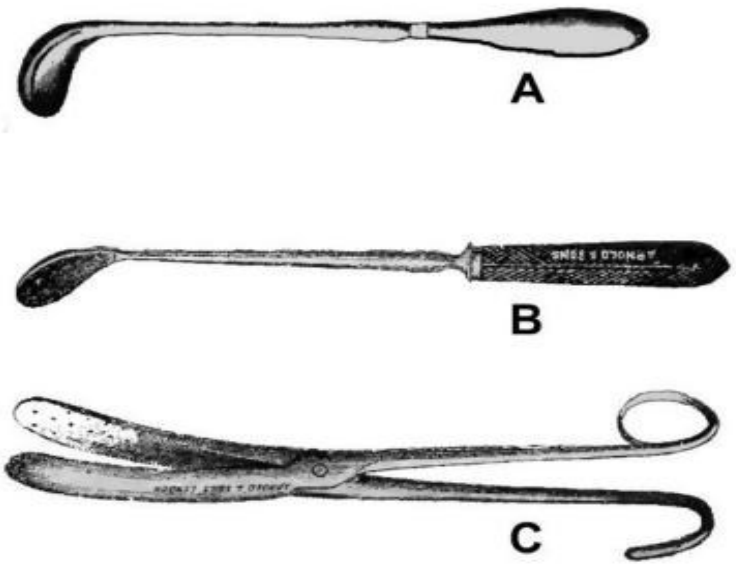

Figure 8. Instruments used by Sushruta and others for stone removal. A. Sarpafana Sala (snake hooded spoon) used by Sushruta (also known as Agravaktra Yantra); B. Eriebsea's Lithotomy Scoop; C. Modern lithotomy forceps [25].

Sushruta's description of the operation is intriguing; '*The left index and middle fingers, with cut nails, are dipped in oil and introduced into the rectum, and then are pressed forwards until the stone is grasped and stands out like a tumour*'[26]. Even at this stage, Sushruta warns the surgeon that if the patient faints upon grasping the stone, the operation should be abandoned, otherwise '*the patient will surely die*'[26].

The actual surgical procedure is described meticulously; '*An incision should then be made on the left side of the raphe of the perineum at the distance of a barley corn and of sufficient width to allow the free egress of the stone. Several authorities recommend the opening to be on the right side of the raphe of the perineum for the convenience of the operation. Special care should be taken in extracting the stone from its cavity so that it may not break into pieces nor leave any broken particles behind, however, small, as they would in such a case, be sure to grow larger again.*'[27].

Sushruta proceeds to give postoperative instructions for the patient to sit in warm water, which was thought to prevent the accumulation of blood in the bladder. However, if blood does accumulate in the bladder, he states, '*a decoction of the Kshira-trees should be injected into the bladder with the help of a urethral syringe*'[27].

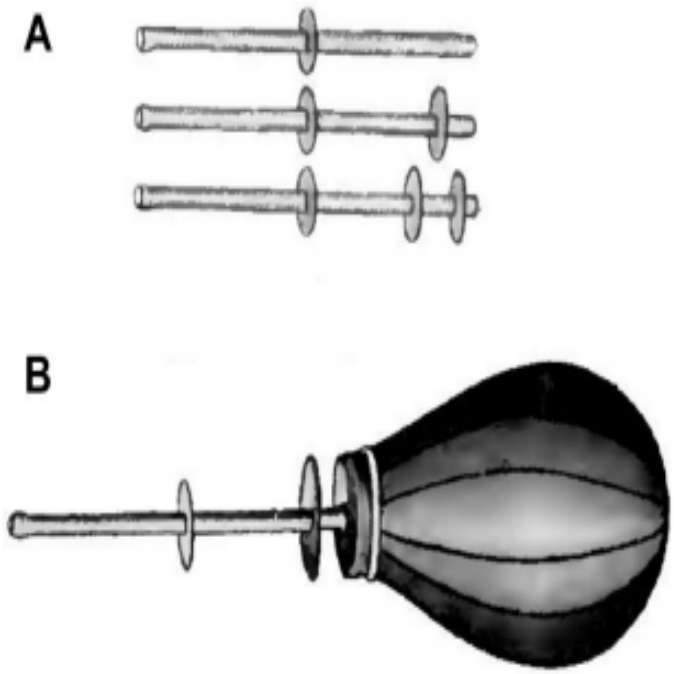

Figure 9. Bladder irrigation devices used by Sushruta. A. Pushpanetra (Pushpa means flower; netra means eye or stalk). B. Vasti Yantra (Bladder syringe) mounted onto pushpanetra [25].

IV. Greco-Roman Antiquity (332 BCE – 476 CE) :

Greco-Roman antiquity refers to the cultural and historical period that encompasses the civilizations of ancient Greece and Rome, typically spanning from the conquest of Egypt by Alexander the Great initiating the spread of Hellenistic culture in 332BCE up to the deposition of the last Western Roman Emperor Romulus Augustulus, and with it the fall of the Western Roman Empire.

The contributions from this era in various fields notably art, literature, philosophy, politics, and science laid the foundational principles of Western civilization. Notable achievements include the establishment of the first democracy in Athens, advancements in mathematics and science by figures like Euclid and Archimedes, and significant literary and philosophical contributions like that of Plato and Aristotle that have shaped Western thought for centuries.

In the midst of the effervescence specific to this era emerged a figure, who is traditionally considered to be the "Father of Medicine" in recognition of his lasting contributions to the field, some of which are still relevant to this day.

1. Early Greek observations and practices:

a. Hippocrates and the foundations of medical ethics and practice:

Commonly portrayed as the paragon of the ancient physician, Hippocrates of Kos or Hippocrates II (460-370BCE) was born in the Greek island of Kos into a hereditary order of priest-like physicians known as Asclepiads. He is mostly accredited with establishing a systematic approach to clinical practice.

Hippocrates was among the first to propose that diseases were caused by natural factors rather than divine punishment or supernatural forces, thus enfranchising medicine and establishing it as a discipline distinct from other fields with which it had traditionally been associated, mainly theurgy and philosophy. He founded the Hippocratic School of Medicine and opened it to those born outside of the Asclepiad class[28].

He stressed with his teachings the importance of clinical observation and documentation, the categorization of illnesses and the treatment based on clinical findings. He is credited with compiling a collection of texts known as the *Hippocratic Corpus*, which includes observations on various diseases and medical conditions, laying the groundwork for clinical medicine[28].

Hippocrates also believed that physicians should be empathetic and compassionate towards their patients, promoting a humane approach to medical care. He is associated with the Hippocratic Oath, an ethical code for physicians that emphasizes principles such as confidentiality, non-maleficence and beneficence, a code that is still read by any young doctor that wishes to integrate the medical corpus[28].

Hippocrates was the first theorize that the human body contained four bodily fluids (humors) that influenced both health and personality, which later became known as the Theory of the Four Humors. He attributed urolithiasis to imbalances in these humors: blood, phlegm, yellow bile, and black bile. He believed that stones formed when black bile congealed or phlegm hardened within the urinary system. Treatments focused on restoring humoral balance through dietary modifications, hydration, and the use of herbal diuretics[29].

Figure 10. "Hippocrates Refusing the Gifts of Artaxerxes" by the French artist Girodet, 1792.

In the *Hippocratic Corpus*, Hippocrates described symptoms consistent with kidney and bladder stones. He presented the following description of bladder calculi: '*The disease has five signs – pain when one wishes to urinate, passage of the urine drop by drop as in strangury, blood-stained urine, the bladder being ulcerated by the stone, inflammation of the bladder, passage of the sand in the urine'* [30]. In this context the use of the word 'strangury' suggests dysuria and retention. These observations are more so remarkable knowing that there is no proof of the practice of dissection at that time.

He also describes four diseases of the kidney and it seems the first refers to renal colic; '*First disease of the kidneys. An acute pain is felt in the kidney, the loins, the flank and the testis of the affected side; the patient passes urine frequently; gradually the urine is suppressed. With the urine, sand is passed; as the sand passes along the urethra, it causes severe pain which is relieved when it is expelled; then the same sufferings begin again. Also, when the patient urinates, he rubs his penis because of the pain'* [31]

Hippocrates adamantly stated that wounds of the bladder were lethal. To this date, lithotomy was practised with only perineal incisions and the delay in suprapubic lithotomy may be ascribed to Hippocrates' warning. In the Hippocratic Oath he stipulates, '*I will not cut persons labouring under the stone but will leave this to be done by practitioners of this work*'. This admonition to physicians about a very risky procedure was to be held for centuries, but his reasons for this may never be known. Perhaps this is the earliest description of specialization within urology [24], [32].

b. Contributions of Ammonius of Alexandria:

Ammonius of Alexandria was a pioneering Greek physician and surgeon who lived during the 3rd century BCE known for his revolutionary contributions to lithotomy. Until this time, lithotomy was to be performed with removal of the intact stone, and Sushruta categorically states this in his work. Ammonius of Alexandria was the first person to suggest crushing the stone to facilitate its removal[26].

Ammonius was given the nickname 'Lithotomus', which was the first time this word was used, and referred to cutting the stone. It is only later that this term was used for the operative procedure pertaining to stones.

One of Ammonius's most notable innovations was the use of a special tool to crush large bladder stones. This method, often referred to as "lithotripsis" (stone crushing), involved breaking stones into smaller fragments that could be expelled naturally or removed with less invasive techniques[24].

Ammonius's crushing tools were among the most advanced of their time, demonstrating a significant leap in medical engineering[33]. His innovation anticipated modern approaches such as extracorporeal shock wave lithotripsy (ESWL) and ureteroscopy, used today for minimally invasive stone fragmentation.

c. Honourable mention: Herophilus and Erasistratus

The first known individual to conduct systematic dissection of human cadavers was the Greek physician Herophilus of Chalcedon, who lived in the early 3rd century BC. He is often credited with performing the first public dissections, particularly in Alexandria, where he and his contemporary Erasistratus advanced the study of human anatomy through detailed anatomical investigations[34].

He provided detailed accounts of the bladder, urethra, kidneys and was to the first to identify the prostate. Herophilus distinguished between different parts of the urinary system and described their functions, contributing significantly to the understanding of urological anatomy, thus contributing to a better understanding of urological pathologies notably urolithiasis[34].

2. Roman advancements in urolithiasis treatment:

a. Celsus and the codification of surgery:

At the beginning of the Christian era, Cornelius Celsus (25 BCE to 40 AD) was a Roman encyclopedist who made it his life's work to synthesize all medical knowledge known up to that point in time. In *De Medicina*, which is believed to be the only surviving section of a much larger encyclopedia, Celsus provided one of the earliest extensive descriptions of lithotomy[24].

His description of lithotomy was a landmark in the history of urology, as it was practised with very little change, indeed if any, until the 18th century **(Fig. 11).** He advised the procedure to be carried out only in the spring, between the ages of 9 and 14 years, and was suitable for females and males. For preoperative preparation, he states that the patient must drink nothing but water for some days before the operation, and meanwhile the patient must take exercise by walking to facilitate descent of the stone to the bladder neck[35].

The operation must be carried out in a warm room, and similar to Sushruta, he states that a strong and intelligent assistant should sit at the head of the patient to hold him down. He also stipulates the use of two assistants if the 'patient be rather powerful' (Fig. 12)[24].

The description of the procedure is also similar to that described by Sushruta, with the surgeon placing two fingers into the rectum. He too states that the fingernails should be cut, and the right-hand presses on the lower abdomen '*but only gently, to avoid injury to the bladder by pressing too hard on the stone*'[24], [35].

The incision he suggested was in the shape of a crescent '*with the ends of the wounds turned a little toward the thighs … a second transverse incision is made, opening the bladder neck*'. He advocated the use of a thin hook with an '*upper end splayed out into a semicircle, polished and smooth on the outside, the surface in contact with the wound, and roughened on the side which holds the stone; it should be long rather than short*' to engage and extract the stone. His instructions were modified for virgin females, in whom he suggested the fingers '*be introduced per anum as in the male; in a woman per vaginam*'[24], [35].

It is unlikely that any anaesthetic was used for patients in whom these procedures were carried out, and instead alcohol was probably given until the patient was benumbed[24], [35].

Figure 11. A lithotomy operation, as described by Celsus [24].

Furthermore, Roman physicians recognized the role of diet and lifestyle in the formation of urinary stones. High-sodium diets, common in Roman cuisine due to salted and preserved foods, were identified as a contributing factor. Physicians recommended moderation in such foods and increased hydration to prevent stone formation[36].

b. Galen of Pergamon:

Galen of Pergamon (129–216 CE), one of antiquity's most influential medical figures, was a follower of Hippocrates, whose works he reinstated. Many consider Galen second only to Hippocrates in fame and importance. He conducted extensive dissections of animals to study the urinary system. His descriptions of the kidneys, bladder, and ureters, though based on animal models, provided a detailed framework for understanding human anatomy[33].

Galen proposed that stones formed due to the thickening or congealing of humors in the urinary tract. As he stated in a phrase from his treatise *De Locis Affectis*: *"When humors grow dense and earthy, stones are formed."*

He also added to the growing literature for stone disease with his view that abscesses, ulceration of the kidney and haematuria were conditions caused by calculi, in the form of sand or larger stones.[24]

He recommended treatments to "thin" the urine, such as increased water intake and avoidance of foods believed to promote stone formation, including dry wines and salted meats. His emphasis on dietary management resonates with modern preventive strategies[37].

MIDDLE AGES

Urolithiasis was a well-recognized medical condition throughout the Middle Ages. The understanding of urolithiasis was shaped by ancient Greek and Roman knowledge, preserved through Byzantine scholarship, and later expanded upon by Islamic scholars. This chapter, through the analysis of medical texts and treatises, explores the evolution of the understanding of urolithiasis in the Middle Ages, tracing its progression from the early medieval period through to the late Middle Ages.

I. Early Middle Ages (5th - 10th century): Preservation of ancient knowledge

With the fall of Rome in 476 CE, many scholarly activities and medical practices declined in Western Europe. The collapse of centralized institutions in the West led to a period of political instability and a general loss of scientific and medical knowledge. The West's medical infrastructure, which had flourished under Roman rule, faced a significant setback, with medical schools collapsing and the availability of medical texts dwindling.

The early Middle Ages saw a relative stagnation in medical advancements in Western Europe. However, Byzantine scholars preserved and expanded upon the knowledge of Greek and Roman medicine, which was later transmitted to both the Islamic and Western European worlds.

1. The influence of the Humoral Theory:

During this period, the humoral theory proposed by Hippocrates (460-370BCE) and further expanded and popularized by Galen (c. 130-200 CE) remained the dominant medical paradigm. It stated that urolithiasis was caused by an imbalance of the body's humors, particularly phlegm and bile,

which could solidify and form stones in the kidneys or bladder. Treatments, therefore, sought to restore balance through diet, exercise, and herbal remedies[38].

This theory continued to guide medical practice well into the medieval period, although it would eventually be challenged by more physiological explanations.

2. Byzantine Empire: Heart of medical preservation

The Byzantine Empire, particularly its capital Constantinople, became the primary center for the preservation and expansion of knowledge from the classical period. Byzantine scholars diligently preserved Greek and Roman medical texts that were eventually translated and transmitted to the Islamic world and later to medieval Europe.

Scholars like Aetius of Amida (c. 502–575 CE) and Paul of Aegina (c. 625–690 CE) contributed significantly to the medical knowledge of their time. Aetius of Amida, for instance, wrote a comprehensive medical encyclopedia, *Tetrabiblos*, which included discussions on the causes and treatment of urolithiasis. Aetius emphasized the role of dietary and lifestyle changes to prevent the formation of stones, following the humoral theory[39].

Paul of Aegina, a Byzantine physician, is perhaps best known for his surgical contributions to the treatment of urolithiasis. His medical encyclopaedia, *Epitome of Medicine*, contained one of the earliest detailed descriptions of lithotomy, offering insights into the instruments required and patient care before and after surgery. He gave original descriptions of his procedures in his sixth book (of seven), which was entirely devoted to surgery[40].

His preoperative orders included telling the patient to jump from a height or be shaken to make the stone drop down to the bladder neck. He used the left sided incision as described by his predecessors, and dressed the wound with linen soaked in oil and wine. Haemostasis was treated with drugs such as mallow, frankincense and aloes. To facilitate healing, the thighs were bound together[41].

Paul's description of lithotomy is especially notable because it marked an early, systematic approach to surgical treatment for urolithiasis and emphasized the importance of proper technique to avoid complications such as infection or excessive bleeding, marking a departure from earlier, less refined surgical approaches.[42]

His writings influenced not only Byzantine practitioners but also medical scholars in the Islamic world, such as Al-Zahrawi and Avicenna, who refined these techniques.

II. The Islamic Golden Age (8th – 13th century): Progress and reinterpretation

The Islamic Golden Age refers to a period of remarkable intellectual, cultural, scientific, and economic flourishing in the Islamic world, typically considered to have spanned from the 8th to the 13th century, and extended from the actual Spain to Central Asia and India. It is closely tied to the rise and influence of various Arabic caliphates.

The Arabs and Muslims appreciated Greco-Roman culture and learning. In fact, in the early stages of the Islamic Golden Age, scholars in the Abbasid Caliphate (750–1258 CE) began the process of translating key works from Greek, Persian, and Indian sources into Arabic. These translations provided a foundation upon which Islamic scholars built their own knowledge.

Under the patronage of Caliph al-Ma'mun (813–833 CE), son of the now renowned Abbasid Caliph Harun al-Rashid, the House of Wisdom in Baghdad became the epicenter of this translation effort. Important Greek medical texts, including those of Galen, Hippocrates, and Aristotle, were translated into Arabic. This led to the development of a new medical synthesis that incorporated elements of Greek, Roman, and Indian medicine[43].

1. Key figures and their contribution to urolithiasis:

Several prominent Islamic scholars made direct contributions to the understanding and treatment of urolithiasis. These individuals played a crucial role in advancing surgical techniques, diagnostic methods, and pharmacological treatments.

a. Rhazes – Al-Razi (865–925 CE):

Al-Razi was one of the foremost medical scholars of the Islamic Golden Age. In his book named *Al-Hawi fi al-Tibb*, he precisely explained the anatomy, physiology and pathophysiology of urinary tract diseases, specially the diagnosis and management of urolithiasis[44].

He was among the first physicians to classify urolithiasis into distinct types, recognizing the differences between kidney stones and bladder stones. He emphasized observing symptoms to determine the location and size of the stone, which was essential for devising effective treatments.

He states: "*If the pain begins in the loin and travels downwards with difficulty in passing urine, suspect a stone obstructing the urinary tract*." He carefully described how the nature of the pain could help identify whether the stone was in the kidneys, ureters, or bladder. He also believed that pain becomes worse when the calculi are passing through the ureters; otherwise, patients just *"feel heaviness in the flanks"*[45].

He also states: "… *Kidneys can have stones and their pain resembles this pain of colon and these two must be differentiated. Pain in the loins, sediment in urine, passage of stone or black urine passed with pain several months before denotes stone pain. If there is nausea or the pain follows a meal or is located in the abdomen and more to the front than the back, then it is more likely to be colonic pain. The site of the pain is important: in abdominal colic, the pain is more generalized and tends to be anterior, while in kidney stones, the pain is more limited and tends to be in the back".*

Differential diagnoses between colitis and renal colic and between kidney and bladder calculi were very clearly made by him[45], [46].

He further stated, *"Urine mirrored the circulation in the urinary system"*. He observed physical characteristics of urine and drew clinical decisions from its appearance in those days, when new laboratory analyses for urine examination were not available. He used to scrutinize urine for colour, consistency, deposits, taste, clarity, touch, etc, and classified each finding into various subdivisions and specified the underlying cause and significance of each[46].

b. Abulcasis - Abu al-Qasim al-Zahrawi (936-1013 CE):

Often referred to as the "father of surgery", Al-Zahrawi was a renowned Andalusian physician, surgeon, and author of the monumental medical encyclopedia "*Kitab al-Tasrif*".

In a passage from his renowned book: *"If the urine appears cloudy or contains visible particles, it may indicate the presence of a stone in the urinary tract. The sediment should be closely examined to determine its nature."* He advocated for urinalysis as a diagnostic tool to identify stone-related conditions. By examining the color, clarity, and sediment of urine, he could predict the presence of kidney or bladder stones[47].

But he is mostly accredited for his pioneering work in the surgical field of urolithiasis. He designed and described surgical instruments specifically for lithotomy **(Fig. 12)**, described it in detail, emphasizing patient preparation, surgical tools, and postoperative care. He recognized the severe pain associated with urolithiasis and developed strategies for pain relief, specifically in a preoperative context, as this passage states: "*When the pain becomes intolerable, a poultice of warm oils or an opiate mixture may be applied to provide relief. This is particularly important before surgical intervention*"[47].

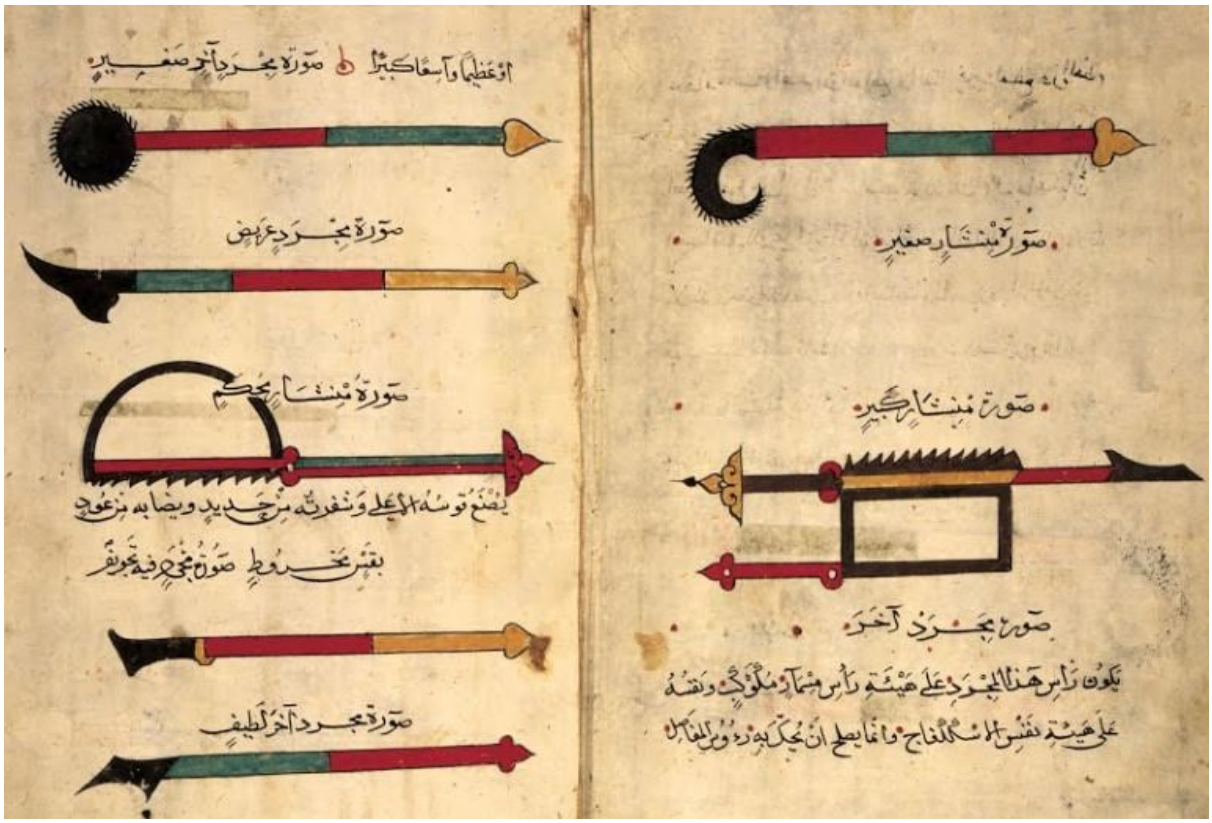

Figure 12. Manuscript describing various surgical instruments of Al-Zahrawi

c. Avicenna – Ibn Sina (980–1037 CE):

Ibn Sina, one of the most influential scholars in Islamic medicine, wrote extensively on urolithiasis in his landmark work, *Al-Qanun fi al-Tibb* (*The Canon of Medicine)*.

Ibn Sina adopted the humoral theory in his medical practice, which was central to his understanding of many diseases, including urolithiasis. According to Ibn Sina, urolithiasis resulted from the imbalance of bodily humors, particularly the bile and phlegm. He believed that excesses of these humors could crystallize and form stones in the kidneys or bladder as this passage states: "*The formation of stones in the kidneys and bladder is caused by the thickening and coagulation of the humors, particularly when the excess bile or phlegm becomes solidified in the urinary system*.[48]"

Apart from detailing the diagnostic signs and symptoms, such as painful urination, blood in the urine, and difficulty in passing urine and stressing the importance of urinalysis, he advocated for dietary adjustments and herbal medications as the first line of treatment for urolithiasis[48].

He also recognized that in severe cases, surgical intervention was necessary. He discussed lithotomy as an option for patients whose stones could not be passed naturally: "*In cases where the stone is too large to pass naturally, the surgeon must resort to lithotomy. The patient should be positioned appropriately, and the operation should be carried out under careful hygiene and anesthesia, using a sharp, well-tempered instrument.*[48]"

2. Surgical innovations and treatments in urolithiasis

a. Lithotomy and surgical tools:

The Islamic Golden Age was marked by significant improvements in lithotomy. Earlier practices, particularly those from Greco-Roman medicine, were enhanced through detailed descriptions of the procedure and the introduction of specialized surgical tools.

- **Al-Zahrawi's Contributions**:

In addition to his systematic description of lithotomy, he emphasized the importance of patient safety during surgery and the meticulous use of tools to prevent complications.

- **Surgical Techniques**: Al-Zahrawi's method modified the technique of lithotomy as practiced by Ancient Greeks. The operation was carried out through a lateral perineal incision down to, then through, the bladder neck to reach the stone and extract it. In his texts, he kept insisting on avoiding the midline perineal incision as it was of high risk.

Abulcasis was also the first to use forceps to extract a bladder stone, before him, extraction of the stone was by an instrument similar to a small spoon that goes around the stone and scoops it out. He also recommended dilation techniques using specialized tools to widen the urethra, facilitating stone extraction[49].

- **Surgical Instruments**: His innovations included forceps **(Fig. 13),** probes, and hooks tailored for stone removal. He also detailed methods for sterilizing tools and maintaining a clean surgical environment.

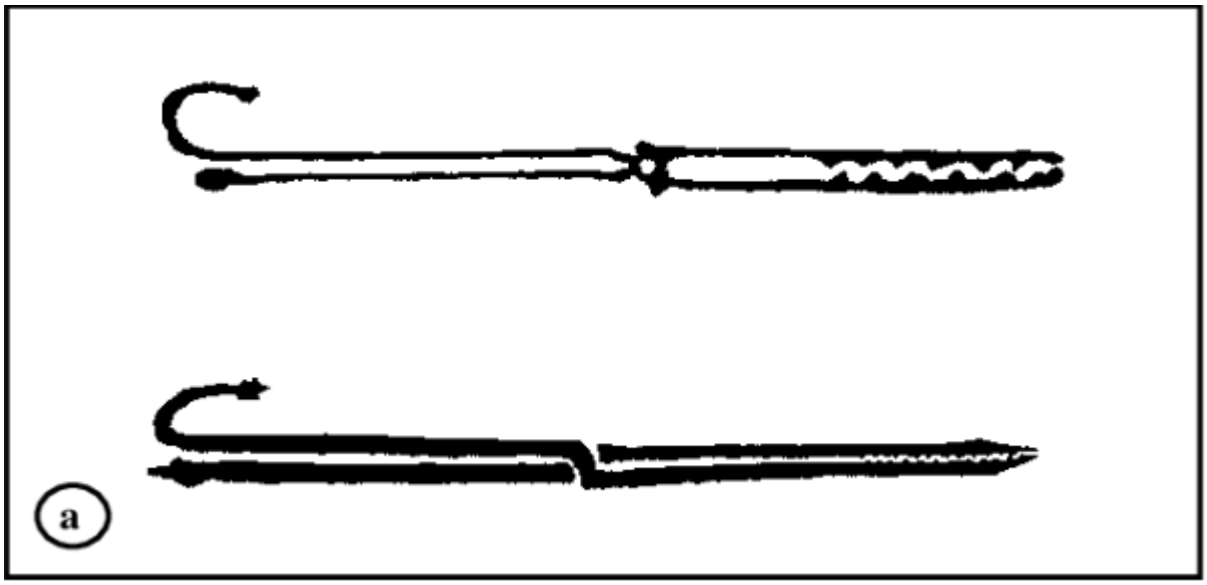

Figure 13. Al-Zahrawi's stone forceps [50]

Passage from *Al-Tasrif*:

"The bladder stone must first be located using a thin probe. A small incision is then made to access the stone. With forceps, the stone is gently removed, ensuring no harm to the surrounding tissue. Care must be taken to sterilize the instruments before use."[51]

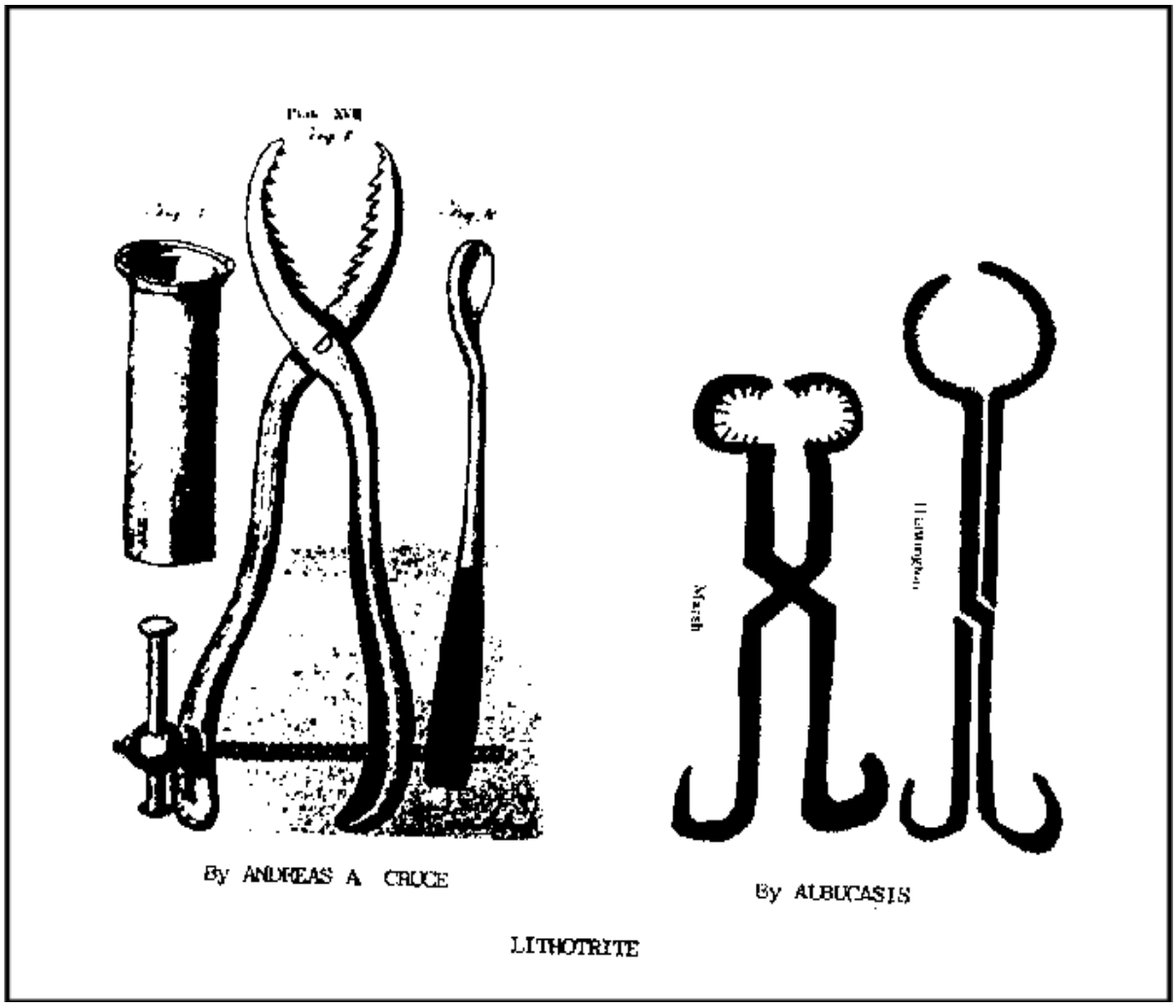

Figure 14. Al-Zahrawi's lithotrite and an 18th century modification of it [50].

- **Avicenna's Refined Approach**:

Ibn Sina (Avicenna), in his seminal work *Al-Qanun fi al-Tibb (The Canon of Medicine)*, detailed the surgical removal of stones, emphasizing precision and post-operative care. He incorporated the use of mild anaesthetics, such as henbane, to reduce pain during surgery. Avicenna also provided detailed instructions for identifying the location of stones and preventing damage to the bladder[52].

Passage from *Al-Qanun fi al-Tibb*:

"If a stone is too large to pass, surgical intervention becomes necessary. The incision must be made carefully, and tools such as hooks or probes should be used to extract the stone. After the procedure, the wound should be cleaned with antiseptic herbal solutions to prevent infection."[52]

b. Herbal and pharmacological treatments:

In addition to surgical techniques, Islamic physicians developed a sophisticated pharmacological approach to managing and preventing urolithiasis. They combined herbal remedies with dietary guidelines to dissolve or prevent stone formation.[53]

- **Al-Razi's Contributions**:

Al-Razi (Rhazes), in his work *Kitab al-Hawi*, recommended various diuretics to aid in the elimination of bladder stones. These included:

- **Parsley** (*Petroselinum crispum*): Known for its diuretic properties, it was used to increase urine output and flush out small stones.
- **Coriander** (*Coriandrum sativum*): Prescribed to reduce inflammation and promote the expulsion of urinary stones.

Passage from *Kitab al-Hawi*:

"For patients with urinary stones, parsley water should be given regularly to ease urination. Coriander, when boiled into a decoction, can soothe pain and aid in expelling stones."[54]

✦ **Avicenna's Remedies**:

Avicenna devoted a significant portion of *Al-Qanun fi al-Tibb* to the use of herbs and minerals for treating urolithiasis. He identified substances believed to break down stones and prevent recurrence:

- **Celery seeds** (*Apium graveolens*): Used to dissolve stones and prevent new ones from forming.
- **Pomegranate rind**: Believed to have stone-breaking properties when consumed as a decoction.

Passage from *Al-Qanun fi al-Tibb*:

"Pomegranate rind, when boiled and drunk, can dissolve stones lodged in the bladder. Celery seed is an effective preventative remedy when consumed regularly."[52]

✦ **Holistic Management Approaches**:

Islamic physicians combined pharmacological treatments with dietary advice, urging patients to drink plenty of water and avoid foods that could exacerbate stone formation, such as salty or overly dry diets.

RENAISSANCE AND EARLY MODERN PERIOD

The Renaissance was a significant cultural movement and period in European history that marked the transition from the Middle Ages to modernity. During this era, there was a revival of interest in classical Greek and Roman texts, which significantly influenced the development of scientific thought. However, it was the new emphasis on empirical observation, human anatomy, and dissection that catalyzed a more rational understanding of urolithiasis.

I. Historical contextualization:

The Renaissance marked a pivotal moment in the history of medicine, as the revival of classical Greek and Roman texts brought renewed interest in understanding diseases like urolithiasis. During this period, there was a transition from purely humoral explanations for diseases to more anatomically-based understandings. Ancient works of Galen and Hippocrates were meticulously studied and translated, providing early frameworks for comprehending the formation of stones in the urinary tract[55].

Urolithiasis, often referred to as "the stone disease," was commonly addressed in Renaissance medical literature. Physicians began to question Galenic humoral imbalances as the sole cause of stone formation, favoring direct observation and dissection. Notably, the development of printing technology in this era enabled the dissemination of medical knowledge, leading to the publication of influential texts on urological diseases[56].

II. Innovation in anatomy, understanding and treatment approaches:

1. Human dissection and advances in anatomy:

The Renaissance period saw the rise of human dissection as a cornerstone of medical education. Andreas Vesalius (1514–1564), often referred to as the father of modern anatomy. Through practicing meticulous dissection that led up to his groundbreaking work, *De humani corporis fabrica* (1543), he corrected many misconceptions about the human body, including the structure and function of the urinary tract **(Fig. 15)**. Vesalius's findings were instrumental in providing a more accurate understanding of the kidneys, ureters, bladder, and urethra, which are central to the study and treatment of urolithiasis[57].

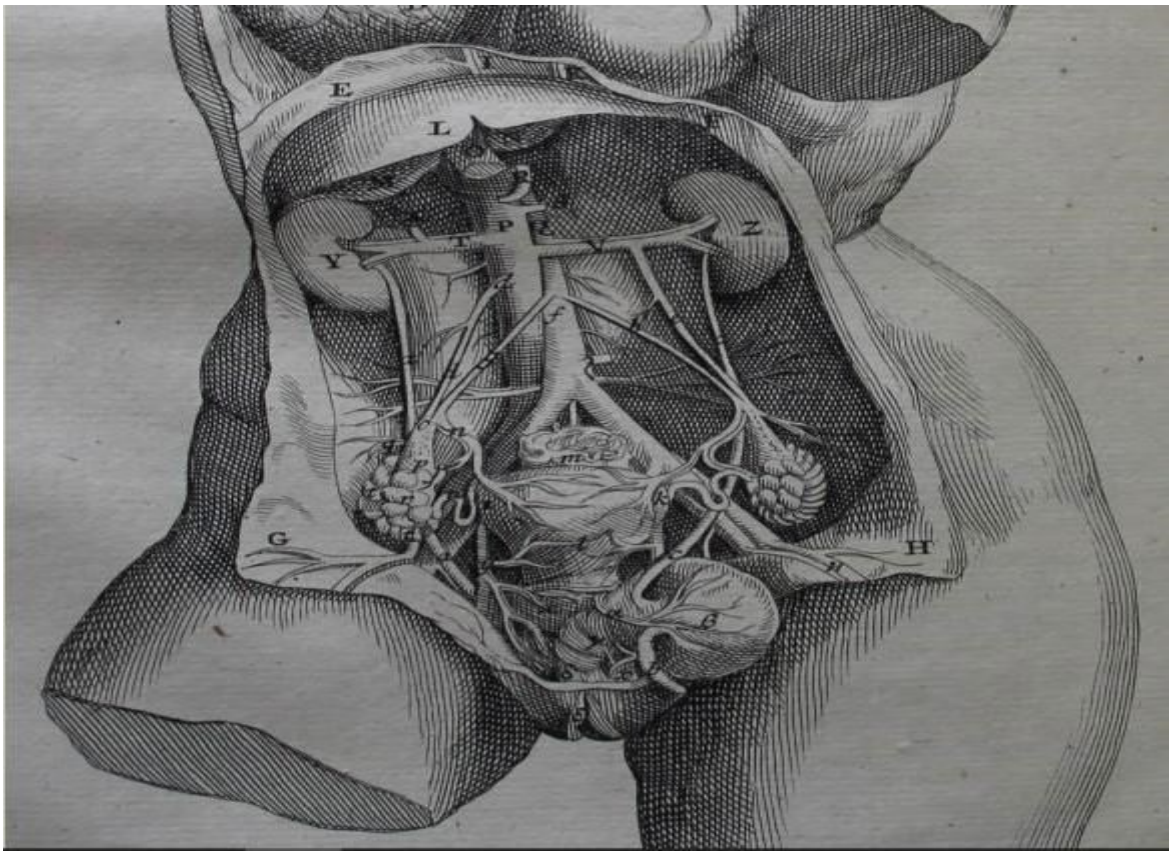

Figure 15. Sketch of detailed female urogenital apparel by Andreas Vesalius [58].

The kidneys and their role in filtering blood were better understood due to advancements in anatomy during the Renaissance. Vesalius's dissections revealed the detailed structure of renal arteries, veins, and the renal pelvis, paving the way for future studies on how metabolic imbalances could lead to stone formation. This anatomical knowledge helped physicians link urolithiasis to renal dysfunction and systemic health, shifting away from purely humoral theories[56].

One of the most significant breakthroughs of the era was the identification of the ureters as conduits between the kidneys and the bladder. This discovery provided insight into how stones could migrate from the kidneys to the bladder, causing symptoms such as pain and hematuria[59].

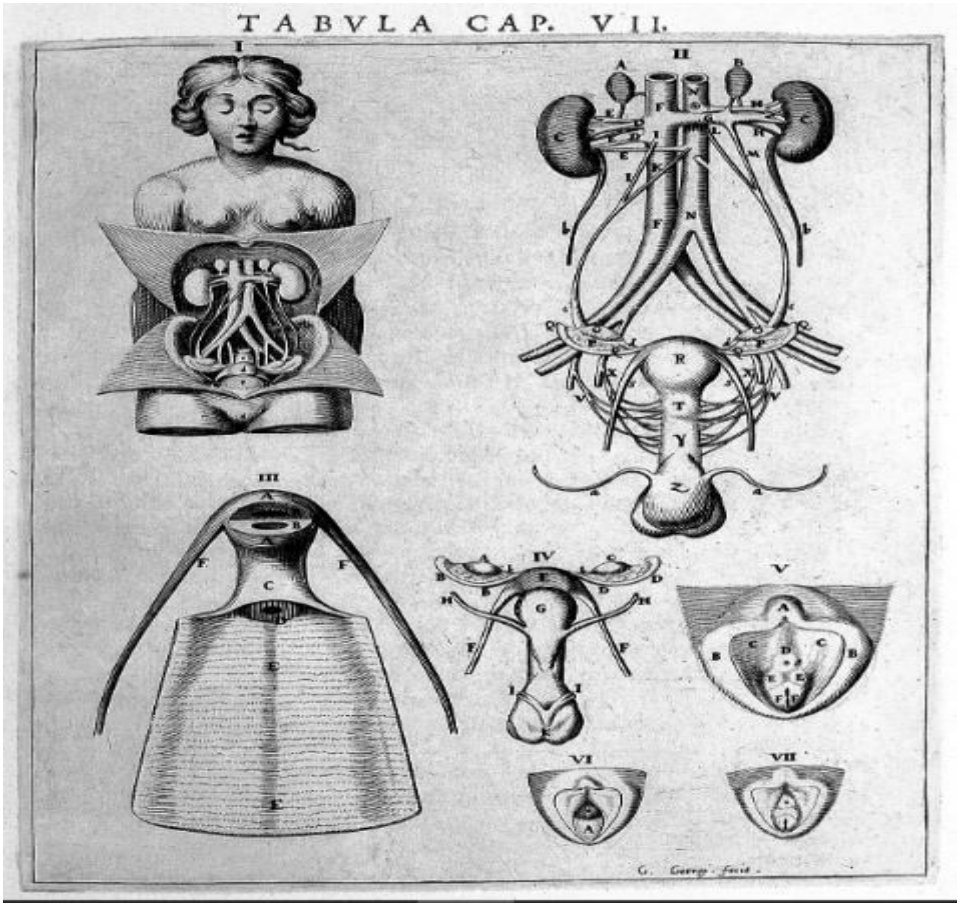

Figure 16. Anatomical sketch describing in detail the female urogenital tract [60].

The lateral perineal lithotomy, refined during the Renaissance, exemplified the integration of anatomical knowledge into surgery. Surgeons like Pierre Franco carefully studied the pelvic anatomy to minimize complications such as hemorrhage and infection. The procedure's success highlighted the importance of accurate anatomical knowledge in achieving favorable surgical outcomes for patients with urolithiasis[57].

2. Surgical Advancements: From Barber-Surgeon to Recognized Profession

a. Surgery as a legitimate profession:

In 1215, by the Fourth Lateran Council, a papal edict forbade physicians (most of whom were clergy) from performing surgical procedures, as contact with blood or body fluids was viewed as contaminating to men. As a result, the practice of surgery was relegated to craft status with training by apprenticeship through guilds. Physicians followed a university-directed program of education which allowed no independent thought or inquiry[61].

Competition among physicians and surgeons, including the lowest group of surgical practitioners, the barbers, continued until Henry VIII signed a charter in 1540 uniting barbers and surgeons in London. The establishment of professional guilds, such as the Company of Barber-Surgeons in England (1540), forerunner of the Royal College of Surgeons, helped standardize surgical practices, which set the stage for legitimizing surgery as a

Profession[49], [61].

These guilds regulated the training and licensing of surgeons, gradually elevating their status. Surgeons like Ambroise Paré (1510–1590), considered the father of modern surgery, championed the use of innovative techniques

and humane practices. Paré also wrote extensively on lithotomy, describing methods to minimize pain and improve patient outcomes[56].

b. Surgical innovation through key milestones:

- 1475: Colot removed stones from a criminal suprapubically, as new procedures could be tried on criminals during this period. He felt the procedure was cleaner, easier and less likely to cause permanent damage. Although the patient survived, the procedure was forgotten. Perhaps the surgeons of this era still believed in Hippocrates' mandate stating the dangers of operating in the bladder[24], [62].
- 1520: Modification of the technique of lithotomy, as first described by Celsus, by Francesco de Romanis to overcome the difficulty in locating the bladder neck. It was later popularized by his student Marianus Sanctus in his book *Libellus Aureus* and became known as "Apparatus Major" or the Marian operation, because of the many instruments this operation required. He became a renowned lithotomist under the name Mariano Santo of Barletta[63].

The calculus was initially detected by introducing a sound or 'syringa *tentativa*', followed by a grooved sound, or '*itinerarius*'. The incision was made onto the sound using a broad knife, or '*novacula*' **(Fig. 17),** again to the left side of the raphe. An '*exploratorium*' was then introduced along the groove, above which two '*conductores*' were inserted to open up the wound further. He then used an '*aperiens*' **(Fig. 18)** to dilate the passage before introducing the forceps **(Fig. 19).** He also had available two retractors or 'latera'. The fragments of the stone were then removed using a 'cochlear' **(Fig. 20)** [24], [63].

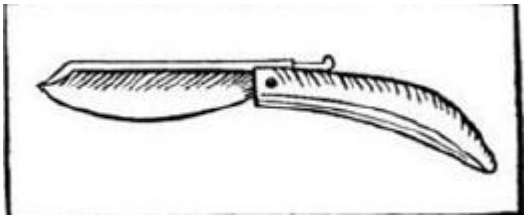

Figure 17. Santo's novacula[24]

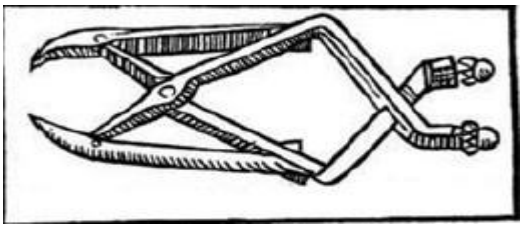

Figure 18. Santo's aperiens [24].

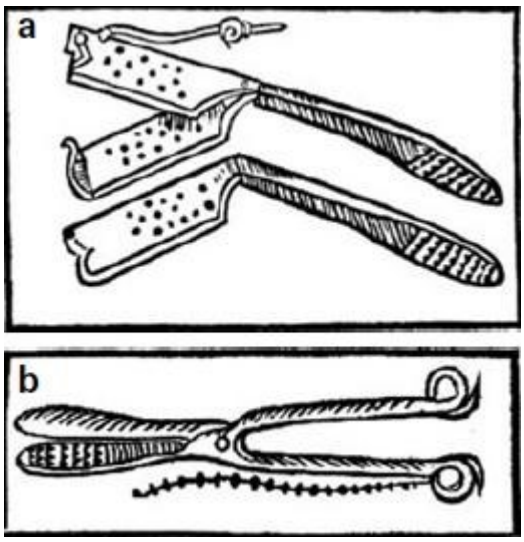

Figure 19. Santo's forceps[24]

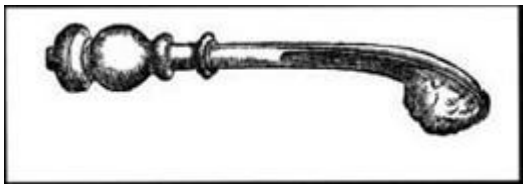

Figure 20. Santo's cochlear [24].

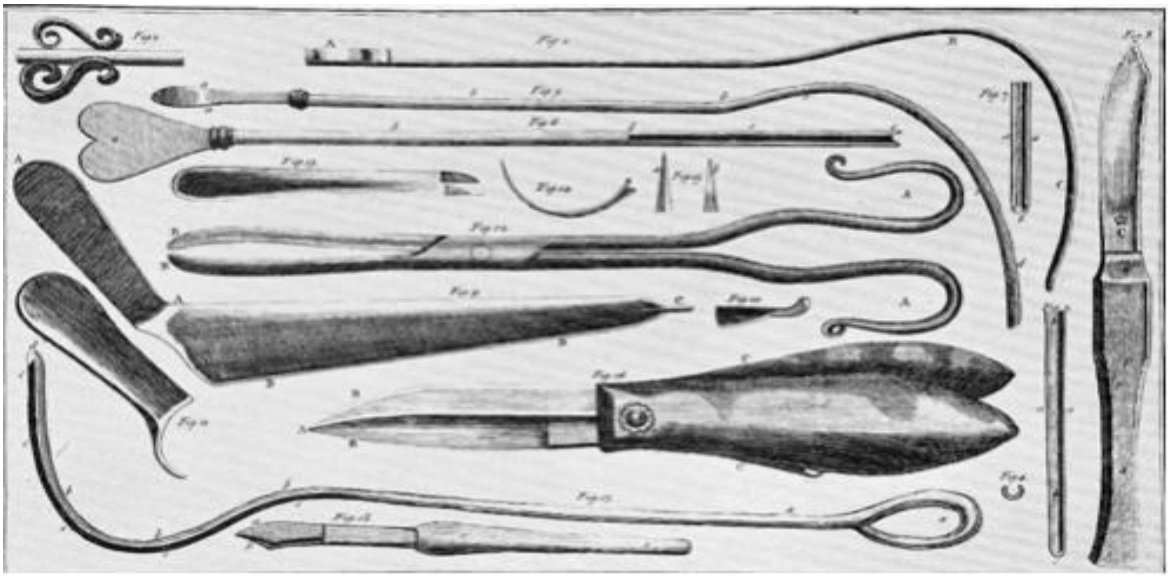

Figure 21. The Apparatus Major. Taken from an 18th Century print, this illustrates the staff, broad knife, gorget and stone forceps [64].

- 1545: Refinement of the technique by 'the father of modern surgery', Ambroise Paré. In his book *La Méthode de Traiter les Plaies,* he describes in some detail closure of the wound using crimson silk sutures, and silver catheter drainage of the bladder[65].

- 1550: The first account of an operation performed on the kidney. Cardan of Milan (1501-1576) opened a lumbar abscess and discovered 18 stones[26]. There is no further mention of this procedure for many years, and it may therefore be accidental that he found the stones[24].

- 1554: Pierre Franco revisiting suprapubic lithotomy in a three-year-old child with a bladder stone in whom a perineal lithotomy had failed. This procedure became known as the Franconian operation for stone in the bladder. Although the procedure was successful, he stated in his works, 'I advise men not to do this', and accordingly after this landmark procedure it was not performed for many years[24], [66].

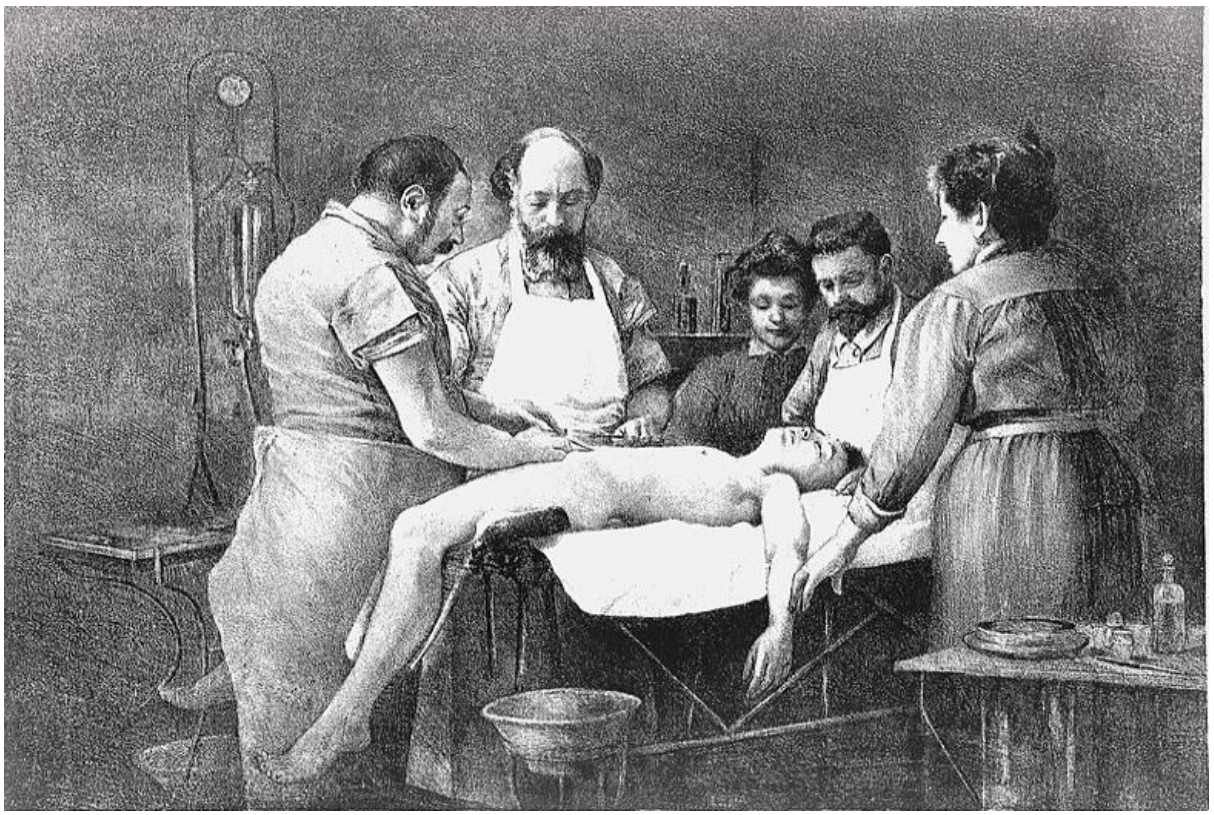

Figure 22. A surgeon performing a suprapubic lithotomy on a young boy. Lithograph by R. Lemoine, 1899.

- 1697: Invention of lateral lithotomy by Jacques de Beaulieu who became a monk under the name Frère Jacques. He learned the trade from an Italian lithotomist and began practising as an itinerant lithotomist. Initially his mortality was very high and so he modified the procedure; he used a grooveless sound, which he passed into the bladder and then made an incision in the perineum, two fingers medial to the ischial tuberosity, down onto the sound[24].

3. Paracelsus, the precursor of chemical medicine:

Paracelsus (1493–1541), born Philippus Aureolus Theophrastus Bombastus von Hohenheim, was a pivotal figure in Renaissance medicine, known for challenging traditional Galenic medicine and introducing a chemical approach to understanding and treating diseases. His philosophy was rooted in the belief that the human body was a chemical system, and diseases were disruptions of this system. This paradigm shift laid the groundwork for a more scientific understanding of urolithiasis, which Paracelsus attributed to an imbalance in bodily salts and minerals[67].

Paracelsus studied the behavior of salts under different conditions, which helped him draw parallels between laboratory experiments and the formation of stones in the human body[67]. He theorized that stone formation was influenced by the interaction between the body's internal chemistry and external substances, such as minerals in drinking water, rather than an imbalance of the four humors[57].

Paracelsus was among the first to advocate for the use of chemical remedies to dissolve urinary stones. He introduced the concept of using mineral-based treatments, such as compounds containing mercury, sulfur, and salts, to restore the body's chemical balance. Paracelsus's *Materia Medica* included formulations that aimed to alkalinize the urine, thereby preventing the crystallization of salts and aiding in the dissolution of existing stones[68].

Some of the treatments he suggested included:

- **Alkaline salts:** He advocated for the use of sodium carbonate among other compounds as a way to neutralize the acidic compounds in the body, which he considered responsible for stone formation[68].

- **Diuretic herbs:** such as parsley (*Petroselinum crispum*), horsetail (*Equisetum arvense*), and nettle (*Urtica dioica*). He argued that by increasing the flow of urine, these treatments could prevent stones from growing or forming altogether[67].

- **Mineral remedies:** Paracelsus advocated for the use of sulfur- and mercury-based compounds, which he believed could alter the chemical environment of the body and dissolve stones. For instance, he suggested that small doses of mercury compounds could "purify" the body of the substances that led to stone formation[69].

- **Thermal and mineral waters:** Paracelsus strongly advocated for the use of mineral-rich waters from natural springs, which he believed had therapeutic properties for dissolving stones[70].

Critics of Paracelsus also pointed out the potential dangers of his treatments, as some of the compounds he used, such as mercury and sulfur, could be toxic in high doses. Nevertheless, his approach to treating urolithiasis represented a significant step forward in the rational, science-based treatment of diseases, contrasting with the more speculative methods of his predecessors[59].

4. Transition to modern urology:

The Renaissance and early modern period set the stage for the development of modern urology by fostering a culture of innovation, precision, and empirical inquiry. Anatomical discoveries, surgical advancements, and the introduction of chemical treatments all contributed to a more sophisticated understanding of the urinary tract.

These contributions bridged the gap between the rudimentary practices of medieval medicine and the more refined techniques of the Enlightenment and beyond[71].

The professionalization of surgery during this period reflected a broader cultural shift toward scientific rigor and specialization. Although urology did not yet exist as a distinct field, the growing focus on specific anatomical systems foreshadowed its eventual emergence[72].

Although we would have to wait a few more years for the advent of revolutionary inventions that influenced the understanding and management of urolithiasis, such as X-rays, anaesthesia and minimally invasive techniques, but this period of time laid the groundwork for future practices, some of which are still relevant to this day.

MODERN ERA

I. Enlightenment and the paradigm shift:

The Enlightenment, also known as the Age of Reason, was an intellectual and cultural movement that emerged in the late 17th and 18th centuries in Europe. It emphasized reason, science, and evidence-based thinking as the primary means of understanding and improving the world.

The 18th century marked a pivotal era where rational thought and empirical observation replaced speculative and humoral explanations of diseases, including urolithiasis. This intellectual movement emphasized systematic scientific inquiry and laid the groundwork for modern medicine[29].

1. The chemical revolution:

By the end of the 18th century, it became possible to determine the composition of urine, as well as the composition of stones, and it was directly or indirectly made possible through groundbreaking discoveries in the field of chemistry.

Among the notable contributors of this era, Carl Wilhelm Scheele's discovery of uric acid in urinary stones in 1776 was a landmark achievement. Scheele's work demonstrated the chemical nature of calculi and connected their formation to specific metabolic processes, providing the first biochemical link between diet, metabolism, and stone disease[73]. His findings underscored the importance of studying bodily fluids and their relation to disease processes, a principle that would drive future research into urolithiasis.

Antoine Lavoisier, a prominent French chemist, is often referred to as 'the father of modern chemistry'. His advancements in chemistry during this period indirectly influenced the study of urolithiasis.

Lavoisier's identification of chemical elements and his work on analytical methods inspired other researchers to investigate bodily fluids and urinary stones with greater precision[74]. By the late 18th century, calcium oxalate was identified as a major component of certain stones, further advancing the understanding of their composition[75].

The following table illustrates the primary types of stones, highlighting when and by whom each type was identified:

Stone type	First identified by	Year	Key characteristics
Uric acid	Scheele, C.W.[73]	1776	Associated with gout
Calcium oxalate	Wollaston, W.H.[76]	1797	Most common type
Cystine	Wollaston, W.H.[77]	1810	Genetic disorder-related
Calcium Phosphate	Ehrenberg, C.G.[78]	1838	Alkaline urine
Struvite	Henschel, J.F.[79]	1839	Infection-related stones

Table 2. Classification of the primary types of stones, the dates representing first scientific documentation of stone composition and characterization

2. Clinical correlation and dietary adjustments:

Physicians like Thomas Sydenham observed links between lifestyle factors, such as high meat and alcohol consumption, and the occurrence of uric acid stones. These observations underscored the multifactorial nature of urolithiasis and introduced the concept of dietary modification as a potential preventive measure. Such correlations hinted at the complex interplay between environmental and metabolic factors in stone formation[29].

Sydenham's clinical observations emphasized the role of patient history and lifestyle analysis in understanding disease aetiology. His work inspired a generation of physicians to adopt a more holistic approach to managing urolithiasis, incorporating dietary and behavioural recommendations alongside traditional treatments. This integration of clinical insights with emerging biochemical knowledge marked a significant evolution in the medical management of stone disease.

II. The 19th century: The era of instrumentation and modern surgery

1. Groundbreaking discoveries:

a. The influence of anaesthesia:

Before the advent of anesthesia, surgical interventions for urolithiasis, such as lithotomy, were fraught with pain, high mortality rates, and limited scope. Lithotomy, the primary method for removing bladder stones, often required surgeons to operate with extreme haste to minimize patient suffering. This urgency led to imprecise techniques, resulting in frequent complications such as excessive bleeding, infection, and incomplete stone removal. The pain was so unbearable that patients frequently went into surgical shock, which was a major cause of perioperative deaths[80].

Kidney stones were rarely addressed surgically during this era because the invasiveness of the procedure and lack of pain control made it nearly impossible to operate safely. This limitation significantly restricted the options for patients suffering from severe kidney stone complications[81].

The revolutionary discovery of ether anesthesia by William T. G. Morton, an American dentist, in 1846 enabled surgeons to conduct operations in a state of patient unconsciousness. Morton demonstrated the use of ether publicly during a surgical procedure at Massachusetts General Hospital, forever changing the field of surgery **(Fig. 23)** [82]

Anesthesia not only improved existing surgical techniques but also paved the way for entirely new procedures. Nephrolithotomy, which involves the removal of kidney stones via an open surgical approach, became a viable option with the use of ether. Gustav Simon performed one of the first successful nephrolithotomies in the 1860s, showcasing how anesthesia could enable surgeons to manage complex urological cases[83].

The success of nephrolithotomy under anesthesia demonstrated its potential to save lives in cases of large or obstructive kidney stones that would otherwise have been fatal. By the end of the 19th century, this procedure had become an essential part of urological practice, thanks to the pioneering work of anesthetic innovators and surgeons like Simon[80].

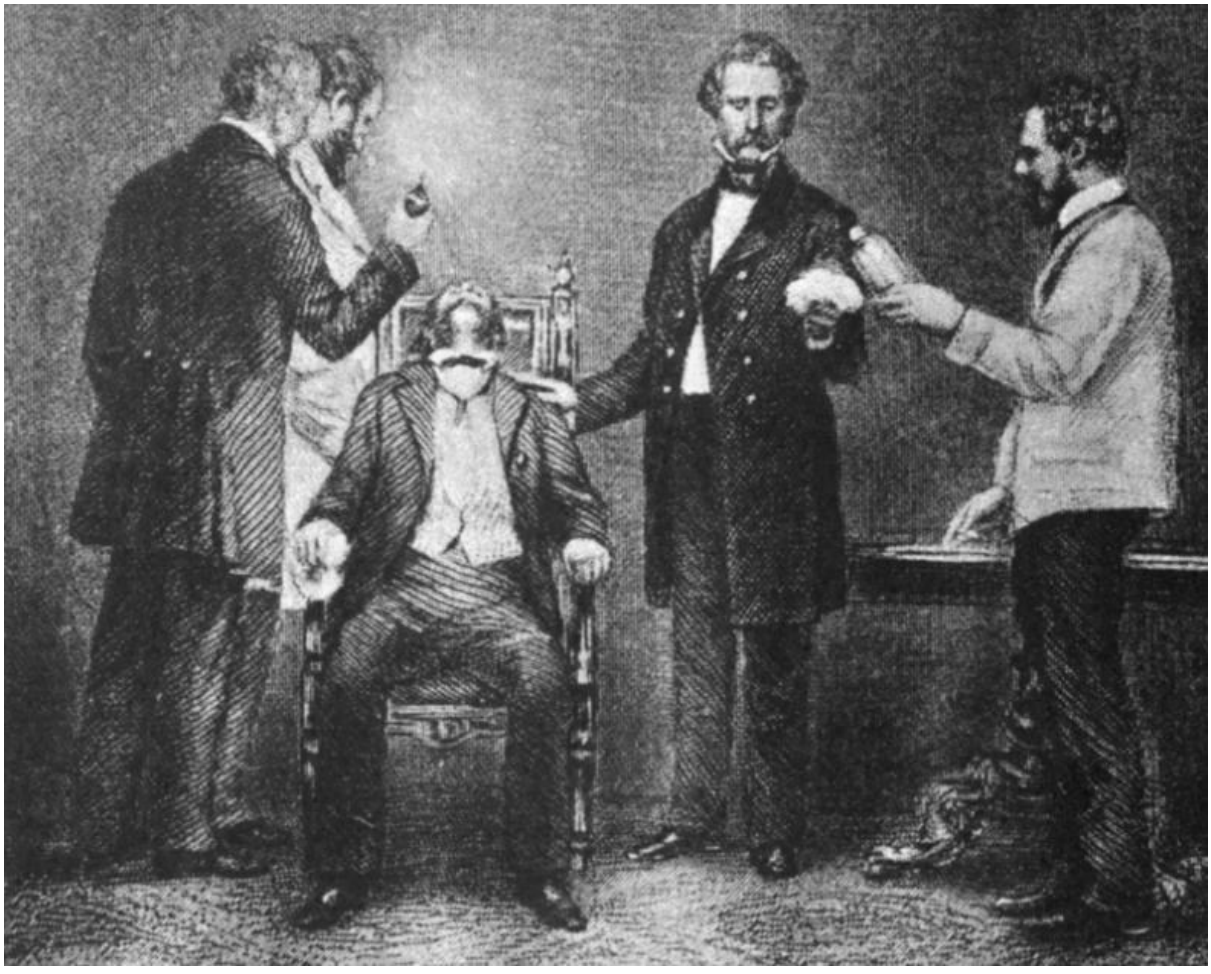

Figure 23. William Thomas Green Morton administering ether anesthesia [84].

b. The advent of asepsis: reducing post-surgical mortality

Before the advent of aseptic techniques, postoperative infections were the leading cause of death in surgical patients. Procedures such as lithotomy and nephrolithotomy, which involved open incisions, frequently resulted in severe infections like sepsis and gangrene. Surgeons often operated in unhygienic environments, reusing instruments and bandages without sterilization[85].The lack of understanding of germ theory meant that surgeons viewed infections as an unavoidable consequence of surgery. Mortality rates for lithotomy in the early 19th century were as high as 30% in some cases, primarily due to infections contracted during or after the procedure[86].

The germ theory of disease, developed by Louis Pasteur in the 1860s, provided the scientific foundation for understanding the causes of surgical infections. Pasteur demonstrated that microorganisms were responsible for infections, challenging the prevailing "*miasma*" theory, which attributed infections to a noxious form of "bad air" (*miasma* meaning pollution in Ancient Greek)[87].

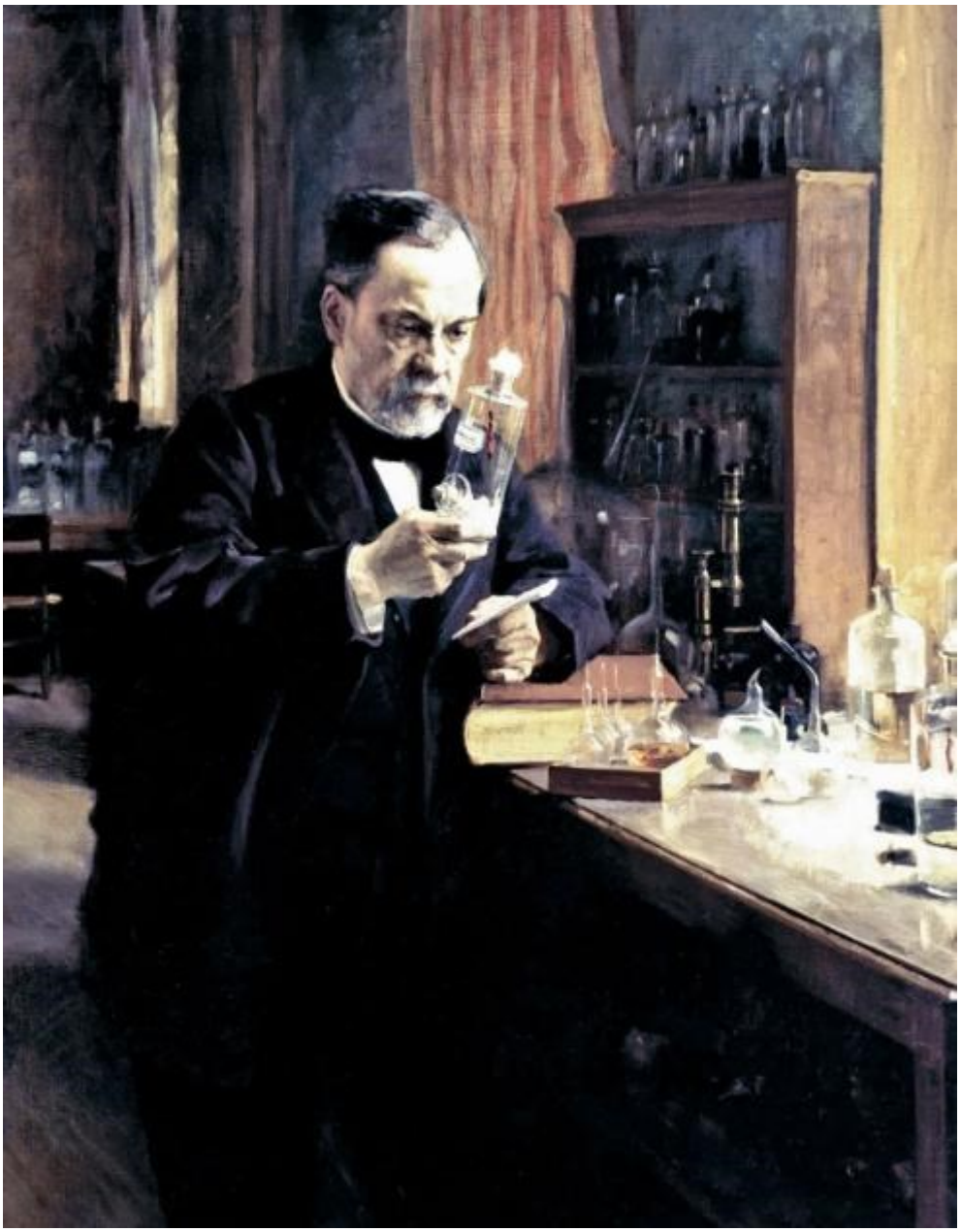

Figure 24. Louis Pasteur in his laboratory, painting by Albert Edelfelt, 1885.

Building on Pasteur's work, Joseph Lister, a British surgeon, applied germ theory principles to surgical practice. In 1867, Lister introduced the use of carbolic acid (phenol) as an antiseptic agent to sterilize surgical instruments and clean wounds, drastically reducing infection rates[88]. His landmark paper, *On the Antiseptic Principle in the Practice of Surgery*, marked the beginning of modern aseptic techniques.

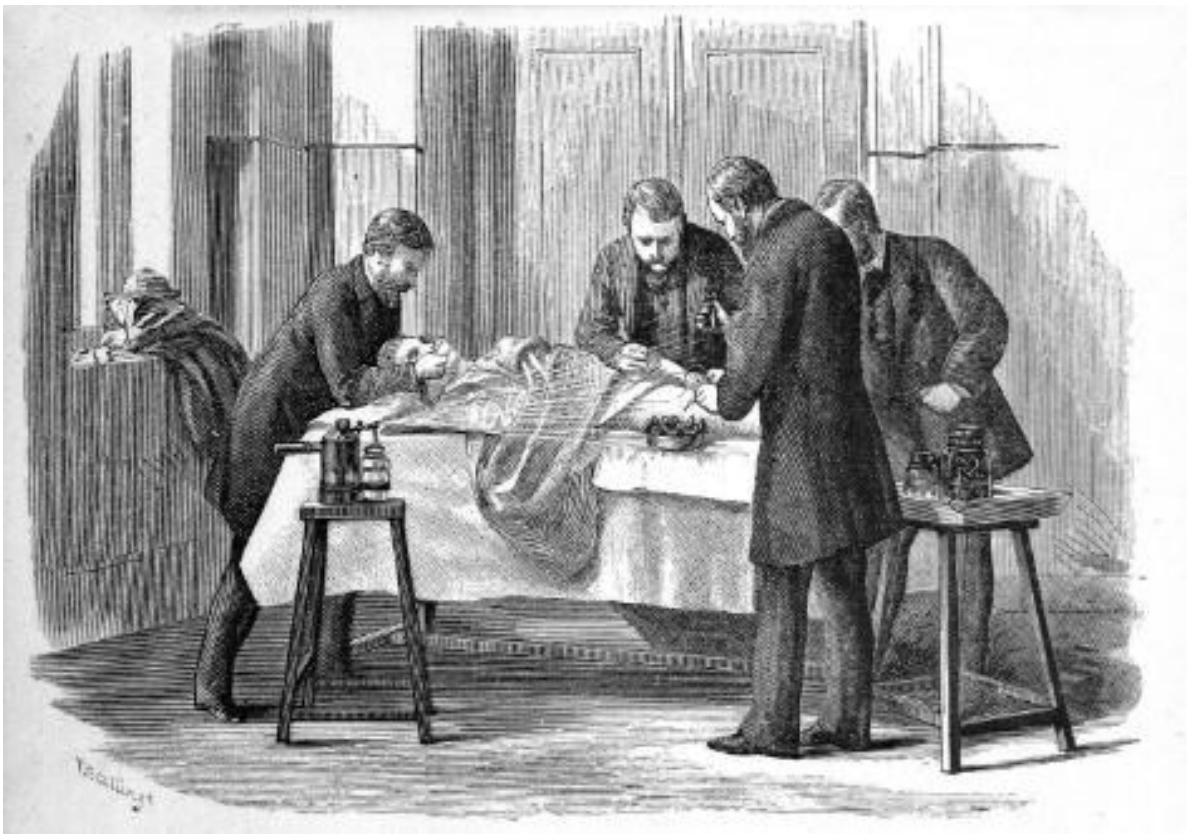

Figure 25. The antiseptic system in practice in an operating room [89].

One of the most significant developments in aseptic surgery was the introduction of instrument sterilization. Robert Koch, a German physician, developed methods for sterilizing surgical tools using heat and steam, which became the standard practice by the late 19th century[90].

The implementation of aseptic techniques had a dramatic impact on the outcomes of urolithiasis surgeries. Mortality rates for lithotomy and nephrolithotomy fell significantly. For example, in hospitals that adopted Lister's antiseptic methods, postoperative mortality rates for lithotomy decreased from 25–30% to less than 5%[86].

The discovery of asepsis revolutionized not only urological surgery but the entire field of medicine. Aseptic techniques remain a cornerstone of surgical practice, ensuring the safety of millions of procedures annually. Innovations such as autoclaves, surgical masks, and sterile disposable instruments trace their origins to the pioneering work of Pasteur, Lister, and Koch[90].

c. Diagnostic revolution:

i. The dawn of endourology:

In 1879, Maximilian Nitze, a German urologist, invented the cystoscope, an instrument that allowed direct visualization of the bladder's interior. Nitze's original design included a telescopic lens and a platinum wire loop heated by electricity for illumination **(Fig. 26).** This innovation marked the first step in the development of modern endoscopic techniques[91].

The cystoscope revolutionized the diagnosis of bladder conditions, including stones, tumors, and inflammatory diseases. For the first time, urologists could observe the bladder in real-time, confirming the presence of calculi and other abnormalities without relying on external imaging or invasive exploration. Nitze's invention underwent continuous refinement, with later models incorporating improved optics, irrigation systems, and even the ability to capture images.

In the context of endourology, the cystoscope served as a cornerstone tool, enabling minimally invasive interventions such as litholapaxy. This procedure, pioneered by Sir Henry Bigelow in the 1870s, involved fragmenting bladder stones using a mechanical lithotrite and flushing out the debris under direct cystoscopic guidance[92].

Figure 26. Nitze's urethroscope and cystoscope [93].

ii. The discovery of X-rays: foundation of radiological diagnosis

Wilhelm Röntgen's discovery of X-rays in 1895 introduced an entirely new way to visualize the human body. By demonstrating how X-rays could pass through soft tissue while being absorbed by denser materials, Röntgen enabled the imaging of bones, stones, and other internal structures[94]. This development was soon applied to urology, where urinary calculi became one of the first pathological conditions to benefit from radiological diagnosis.

For urolithiasis, X-rays provided a non-invasive method to detect stones in the kidneys, ureters, and bladder. Prior to this, diagnoses relied heavily on clinical symptoms or exploratory surgery, both of which carried significant risks. X-rays allowed physicians to identify the size, location, and composition of stones with remarkable accuracy, guiding treatment decisions and reducing unnecessary surgical exploration[94].

In the emerging field of endourology, X-rays became an indispensable tool, facilitating procedures such as stone localization and monitoring especially during minimally invasive interventions.

2. Technical and surgical revolution:

The 19th century heralded transformative advancements in the treatment of urolithiasis, particularly with the development of lithotripsy. These innovations transitioned the management of bladder and kidney stones from invasive and often fatal surgeries to less invasive techniques.

a. The advent of lithotrity:

Lithotrity wasn't a novel concept, Abulcasis had already developed a 'primitive' lithotrite named Mishaab **(Fig. 27).** In his writings, Abulcasis emphasized the importance of safely accessing and extracting bladder stones. Although he didn't crush stones inside the bladder, his surgical expertise was groundbreaking for his time[53].

Figure 27. Abulcasis' mishaab [24].

It wasn't until January 13, 1824, that Jean Civiale first introduced the lithotriptic instrument, modifying the «primitive lithotrite» developed by Abulcasis, which allowed him to break up and then remove the bladder stone through the urethra, at the Neckar Hospital in Paris[95].

He began development in 1817, when he was a second-year medical student. His first crude device was significantly modified by himself and presented to the world only in 1824[96].

Of the three recognized methods of removing a stone from the bladder, i.e. cutting down onto the base through the perineum, and opening the bladder above the pubis, Civiale had adopted the third, i.e. crushing the stone using instruments that are passed along the urethra **(Fig. 28, 29)** [97]. By performing lithotrity **(Fig. 30)** and thus avoiding an incision, Civiale had inadvertently initiated minimally invasive surgery.

It is that event that can be called the beginning of the use of lithotrites and the beginning of «endourology» in stone crushing[49].

Figure 28. Civiale's trilabe [24].

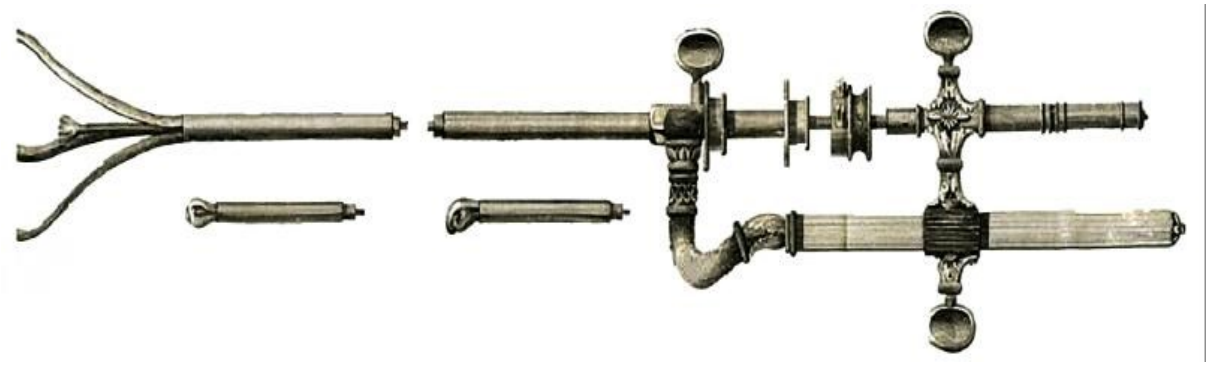

Figure 29. Civiale's lithotrite [98].

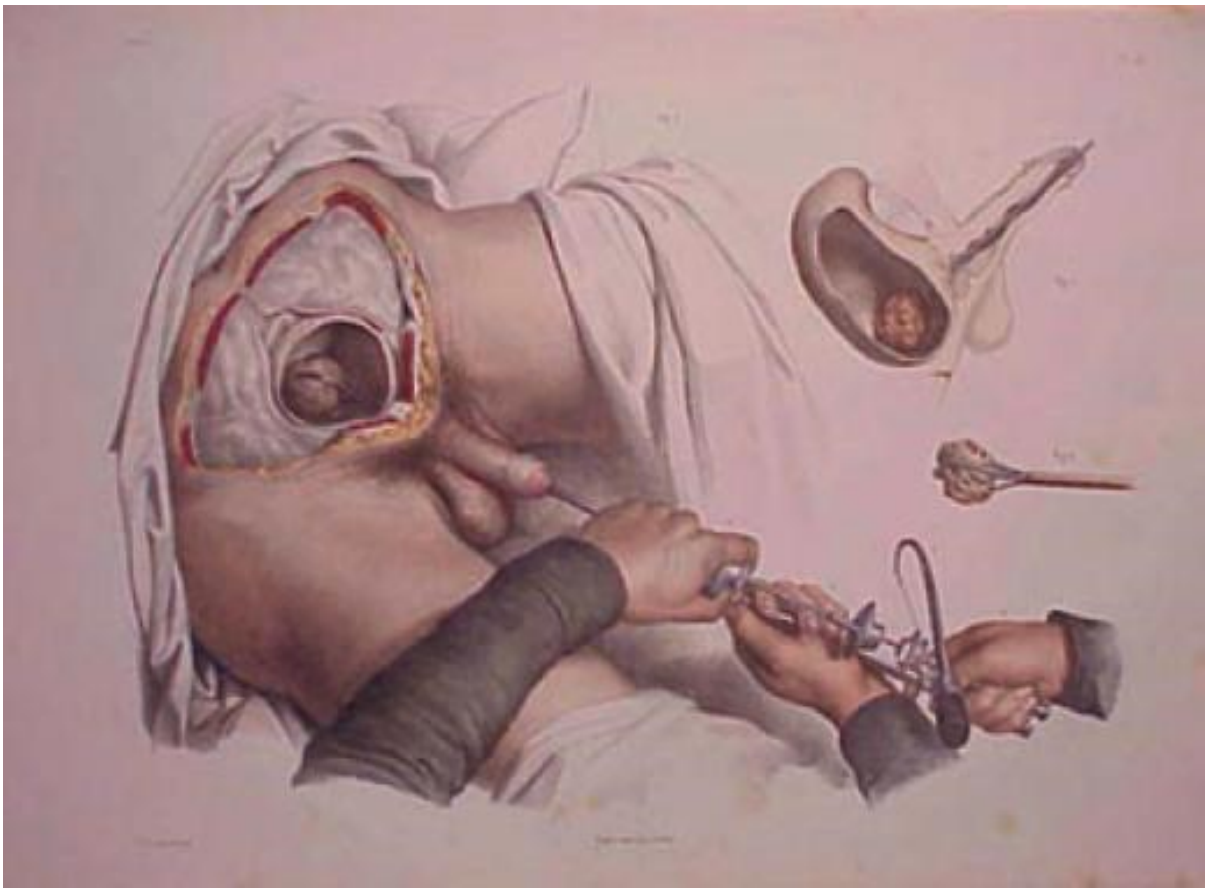

Figure 30. Civiale's lithotrity [24].

In 1832, Charles Heurteloup described the principle of a modern lithotrite in Paris and presented his «percussion lithotrite» **(Fig. 31)** [24].

Figure 31. Heurteloup's percussion lithotrite [24]

However, the problem of evacuating the stone fragments was still in its infancy and often the patient passed them between each session. Although lithotrity was gaining popularity, statistics showed that the mortality of lithotrity was similar to that of lithotomy[24].

b. Bigelow's litholopaxy:

In 1878, Henry J. Bigelow (1818–1890), a Boston urologist, spent much time concerned about the danger of sharp fragments within the bladder after lithotrity. Bigelow concluded that all the stone fragments needed to be removed and he developed a new lithotrite that was harder and stronger, and could crush larger stones **(Fig. 32)** [99].

With the advantage of anaesthesia, he filled the bladder, crushed the stone and evacuated all the fragments in one sitting; this was 'litholopaxy'. He modified and developed a large-calibre evacuation system so that all debris from the bladder was effectively removed. Suddenly the mortality from lithotrity dropped from around 24% to 2.4%[100].

Figure 32. Bigelow's lithotrite and evacuator [24].

c. Historical milestones:

- 1871: Gustav Simon (1824-1876), a German surgeon who had already performed the first planned nephrectomy for a fistula in 1869, performed another for stone disease[101].

- 1873: First nephrotomy was performed by William Ingalls in Boston[24].

- 1879: The first pyelotomy was carried by Heinecke[24].

- 1881: first nephrolithotomy by Le Dentu(1841-1926) in France[102].

- 1889: Kummel and Bardenheuer carried out the first partial nephrectomies for stone disease[103].

III. 20th century breakthroughs:

1. Introduction of imaging technologies:

The introduction of imaging technologies in the diagnosis of urolithiasis began with the groundbreaking discovery of X-rays by Wilhelm Röntgen in 1895. Röntgen's discovery, initially met with skepticism, quickly proved valuable in clinical practice, especially in detecting skeletal fractures. However, it wasn't until the early 20th century that medical professionals began to realize the potential of radiography in identifying kidney stones. Early radiographic methods, though rudimentary, were an important milestone, as they allowed physicians to see internal structures for the first time, helping to identify abnormal densities in the urinary tract, such as kidney stone[104].

Radiological techniques became more refined in the early 20th century, culminating in the development of intravenous pyelography (IVP) in the 1920s, which involved the injection of a contrast dye into the bloodstream, which was filtered by the kidneys and excreted through the urinary tract, outlining the kidneys, ureters, and bladder on X-ray images. IVP became the gold standard for diagnosing urolithiasis, replacing the previous reliance on simple radiographs, and it remained the primary diagnostic tool for kidney stones for several decades[105].

The ability to visualize stones in the urinary tract advanced even further with the introduction of computerized tomography (CT) in the late 20th century. CT scans provided detailed cross-sectional images of the body, allowing clinicians to identify not only the size and location of the stones but also their density and composition. This technology was particularly useful for diagnosing complex cases of urolithiasis, where the stones were located in less

accessible areas, such as the lower ureter. In addition, CT scans allowed physicians to visualize stones in patients with atypical presentations, such as those with silent or asymptomatic stones, leading to better management and treatment planning[106].

2. Instrumental and surgical prowess:

a. Technical advancements:

i. Cystoscopes and ureteroscopes:

At the start of the 20th century, urological instrumentation began evolving to meet the increasing demand for diagnostic and therapeutic interventions. The invention of the cystoscope in the late 19th century by Max Nitze was refined in the early 20th century, with improvements in optics and illumination, allowing better visualization of the urinary tract[91].

With the increasing use of the Nitze cystoscope and the Hopkins rod-lens system, Young and McKay (1870–1945) were able to develop the cystoscopic lithotrite. They were also the first to perform (1912) and report ureteroscopy (1929)[107].

Initially, ureteroscopes were rigid and challenging to maneuver, but over time, improvements in the flexibility and design of ureteroscopes made them more effective and easier to use **(Fig. 33).** The introduction of fiber optics in the 1950s significantly enhanced image quality, making the diagnosis and treatment of urinary tract disorders, including urolithiasis, much more precise[108].

In 1964, Marshall reported his first experience with flexible ureteroscopy using a 3mm fiberscope[109]. This was followed by Tagaki (1971) and Bush (1970). However, it was not until 1977 that purposeful rigid ureteroscopy was reported independently by Goodman and Lyon et al.[49], [110]. Flexible ureteroscopes, popularized in the 1980s, allowed urologists to access previously difficult-to-reach locations, such as the upper ureter and the renal pelvis, without the need for open surgery.

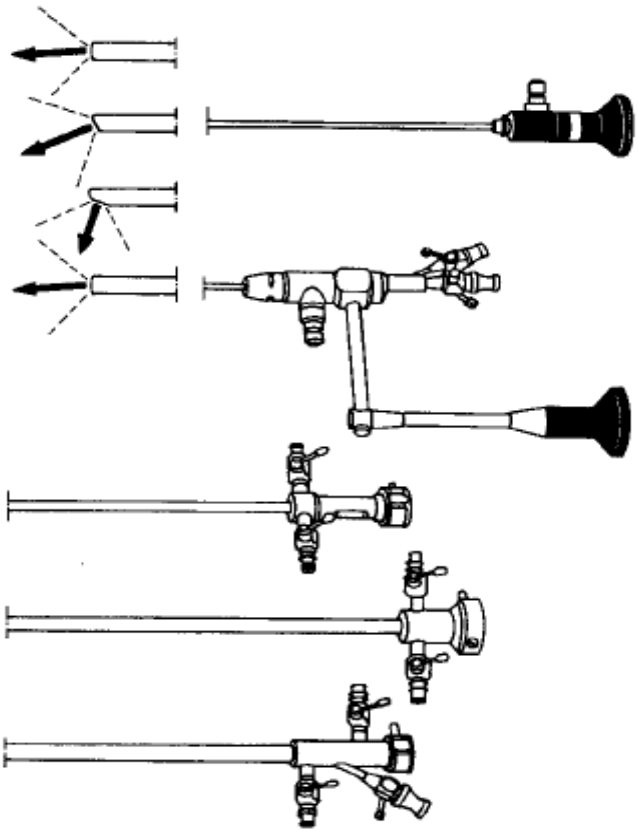

Figure 33. The early rigid ureteroscope designs using interchangeable telescopes with various angles of view [111].

ii. Lithotripsy instruments:

The first instrument for mechanical stone fragmentation, the lithotrite, was introduced in the 19th century and used in early urological practices. However, advancements in lithotripsy instruments became more notable in the 20th century with the advent of various non-invasive and minimally invasive techniques.

Electrohydraulic lithotripsy was the first modern intracorporeal lithotripter invented in 1954 by Yutkin, an engineer from Kiev[112]. Because he was out of favour with Stalinist government, he was banished and the use of his invention was delayed for at least 10 years, when URAT-1 was displayed in 1967. It used an electric discharge to generate a shock wave for stone fragmentation, was widely used during the 1970s and 1980s **(Fig. 34)** [113].

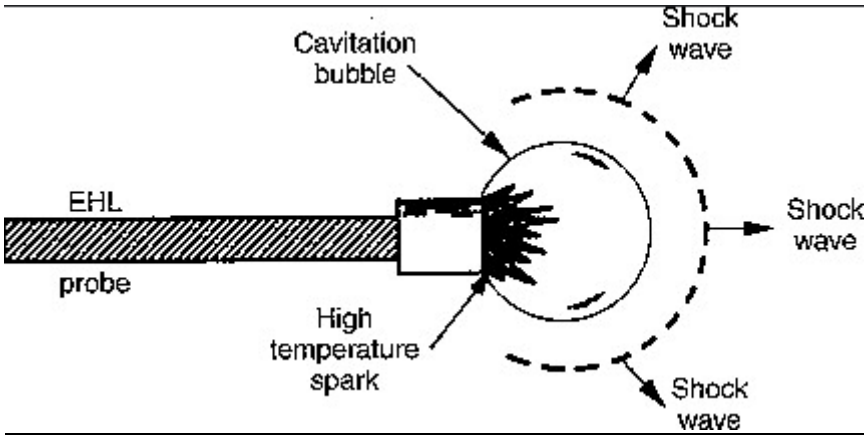

Figure 34. Mechanism of EHL shock wave generation: close-up view of EHL probe. [112]

The first investigation of ultrasound for the destruction of urinary stones was undertaken by Mulvaney in 1953, and Kurth applied it to renal stones in 1977[114].

By the mid-1980s, the introduction of shock wave lithotripsy (SWL) became a game-changer. The first clinical use of SWL by Chaussy et Al. in 1980 allowed for the non-invasive treatment of kidney stones using external shock waves, sparing patients from invasive surgery[115].

The development of *laser* for the fragmentation of ureteral calculi was initiated in 1986[112]. In 1992, the holmium:YAG laser, a powerful and precise tool for breaking up stones, was introduced for use **(Fig. 35)** [116]. This laser's high precision allowed for stone fragmentation while minimizing damage to surrounding tissues. The ability to combine flexible ureteroscopy with laser lithotripsy enabled urologists to treat stones in the renal pelvis, calyces, and ureters with minimal incisions.

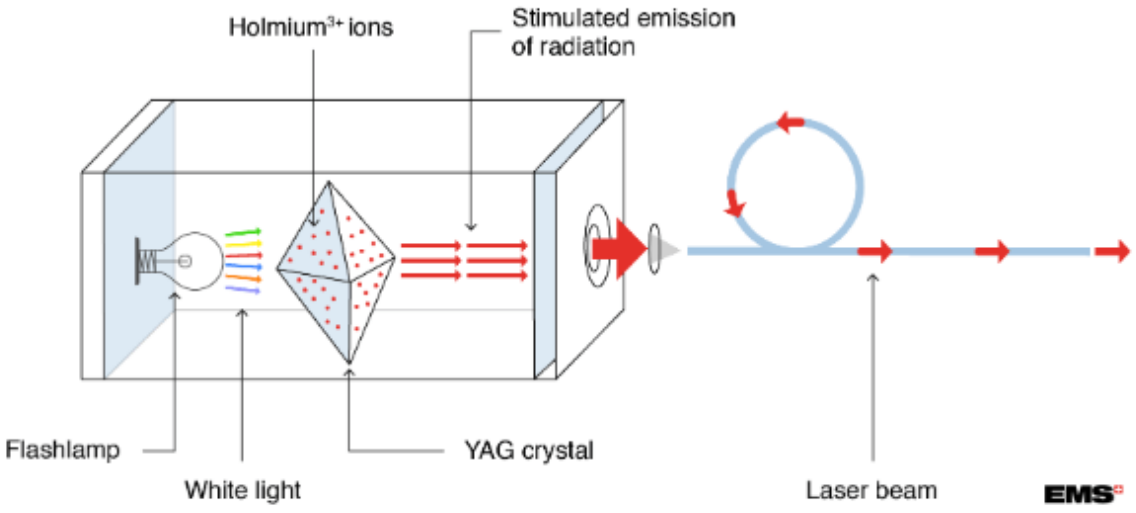

Figure 35. Holmium:YAG laser decomposed [117].

The newest technique approved for the fragmentation of renal, ureteral, and bladder calculi is pneumatic lithotripsy using compressed air. The first pneumatic device, the Lithoclast, was designed by a Swiss company in 1992 **(Fig. 36)** [112].

Figure 36. One of the oldest pneumatic lithotrites by Swiss Lithoclast [118].

b. Minimally invasive techniques:

i. Percutaneous Nephrolithotomy (PCNL):

Percutaneous renal surgery soon started to develop: Rupel and Brown removed a stone in 1941 through a nephrostomy tract that had previously been established surgically[119], and Trattner in 1948 used a cystoscope to examine the renal collecting system at open renal surgery[120]. Goodwin

et al. were the first to place a nephrostomy tube to a grossly hydronephrotic kidney to provide drainage in 1955[121]. It was not until 1976 that Fernstrom and Johannson established percutaneous access with specific intention of removing a renal stone[122].

Percutaneous nephrolithotomy (PCNL) is one of the most significant developments in the treatment of large kidney stones. PCNL involved creating a small incision in the patient's back, through which a nephroscope was inserted to directly visualize and remove kidney stones **(Fig. 37).** Advances in endoscopes and other instruments allowed urologists to refine the percutaneous nephrolithotomy technique during 1970s and large series were reported in 1980s[122].

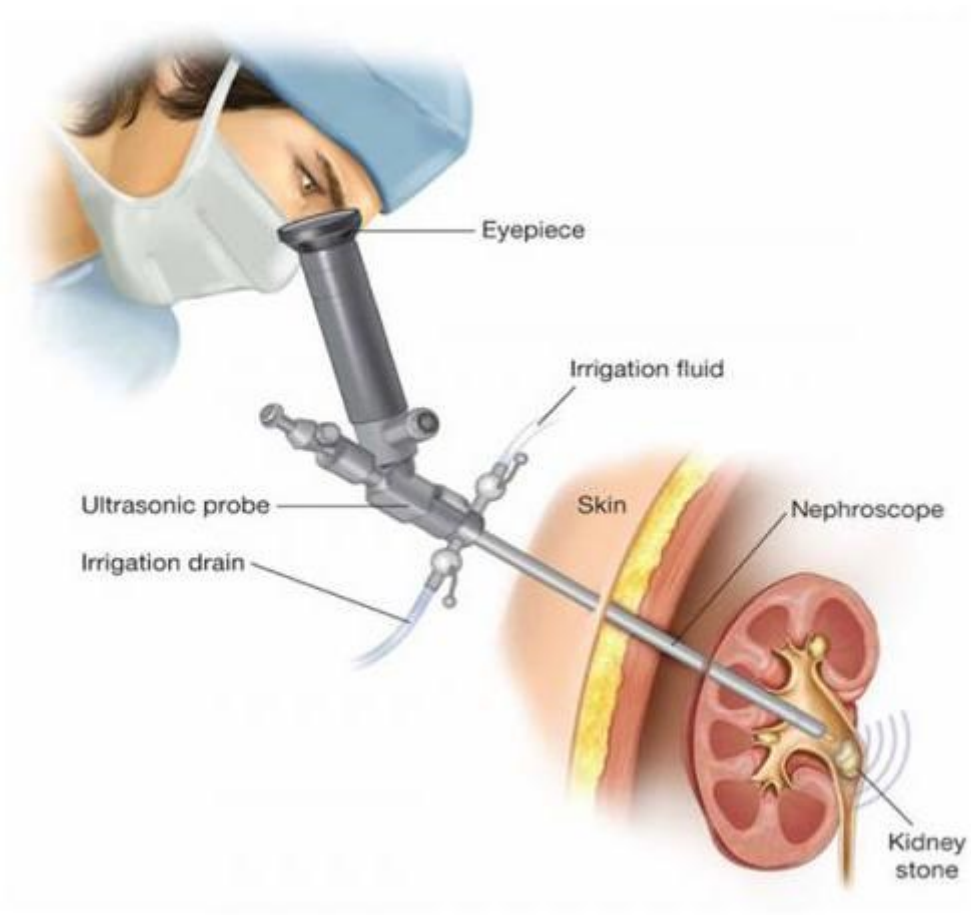

Figure 37. Percutaneous nephrolithotomy [123].

PCNL quickly became the treatment of choice for patients with large, staghorn, or multiple stones. Not only did it reduce the need for open surgery but also resulted in faster recovery times, reduced postoperative pain, and lower complication rates compared to traditional approaches[124]. This was a significant improvement over the older methods, such as open nephrectomy, which required larger incisions, longer hospital stays, and higher risks of postoperative infections and bleeding.

Over the years, various modifications to PCNL, such as the development of smaller access sheaths and the use of ultrasound or fluoroscopy for stone localization, have further enhanced its safety and efficacy. As technology advanced, PCNL became a more common procedure for treating large stones and remains a mainstay in urolithiasis management today.

ii. Extracorporeal shockwave lithotripsy (ESWL):

With the introduction of the first ESWL machine, Dornier HM-1 **(Fig. 38),** in 1980, a dramatic change in stone management was observed[125]. ESWL uses high-energy shock waves generated outside the body to break kidney stones into smaller fragments, which can then be passed out through the urinary tract[115].

One of the key advantages of ESWL is that it can be performed on an outpatient basis with minimal anaesthesia, no surgical incision whatsoever, leading to shorter recovery times and a lower risk of complications compared to traditional surgery. Chaussy et al. demonstrated that ESWL was highly effective in treating renal and ureteral stones, with success rates exceeding 80% for many patients, particularly for smaller stones[115]. Over the years, improvements in ESWL equipment and techniques, including the use of

computerized targeting systems to focus the shock waves precisely on the stone, have increased its precision and efficiency.

By the 1990s, ESWL had become the first-line treatment for many cases of urolithiasis, particularly for stones less than 2 cm in size. Although ESWL is still widely used today, its efficacy can be limited for larger or harder stones, or for stones located in areas that are difficult to reach, which is why other techniques such as PCNL or ureteroscopy are sometimes preferred for complex cases.

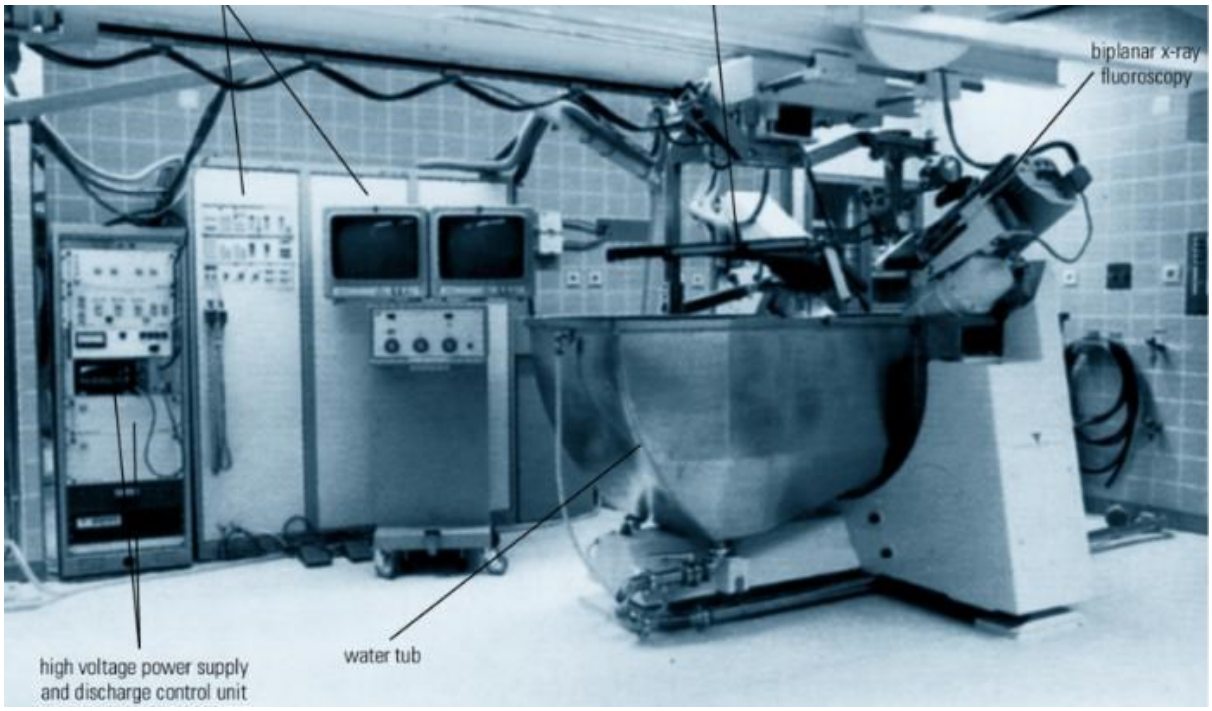

Figure 38. Photograph of the Human Model 1 (HM1) electrohydraulic extracorporeal lithotripter, manufactured by Dornier Medizintechnik in Germany [126].

iii. Ureteroscopy and laser lithotripsy:

In the 1980s, the development of flexible fiber-optic ureteroscopes allowed for the visualization and treatment of stones in the ureters and kidneys through the natural urinary tract. Ureteroscopy, which had been used in limited capacities since the 1960s, underwent significant improvements during this period, becoming more accessible and effective with the introduction of flexible ureteroscopes[127]. These devices allowed urologists to reach stones in the upper urinary tract, which were previously inaccessible through external approaches.

Figure 39. Flexible ureteroscope, image courtesy of the urology department of Tangier

Flexible ureteroscopy, combined with laser lithotripsy, was a transformative advancement in the treatment of smaller stones in the ureters and renal pelvis. The holmium:YAG laser, introduced in the 1990s, became the standard for laser lithotripsy, offering high precision in fragmenting stones with minimal damage to surrounding tissues[116].The ability to visualize stones directly and fragment them using a laser provided patients with a minimally invasive option, leading to faster recovery times, lower complication rates, and the ability to treat stones in previously difficult-to-reach areas.

Ureteroscopy with laser lithotripsy became the treatment of choice for smaller stones in the ureter, particularly for those that were lodged in the mid- or distal segments[128]. The ability to perform the procedure under general or regional anesthesia, with only a small urethral catheter required for access, greatly reduced patient discomfort compared to traditional surgical methods.

Figure 40. Rigid ureteroscope, image courtesy of the urology department of Tangier

c. Transition from open surgery to endoscopic approaches:

Open surgical procedures for urolithiasis, once a mainstay of treatment, were largely replaced by endoscopic and minimally invasive techniques by the late 20th century. Studies demonstrated that procedures like PCNL and ureteroscopy offered safer and more effective alternatives with shorter recovery times and lower complication rates[124].

The combination of endoscopic techniques with pharmacological treatments further enhanced outcomes, reducing the need for invasive approaches[129]. By the 1990s, open surgery was performed in less than 1% of urolithiasis cases in reference centers[130].

3. Pharmacological advancements:

The 20th century saw significant pharmacological breakthroughs in the management of urolithiasis. These advancements aimed to prevent stone formation, dissolve existing stones, and manage associated symptoms such as pain and urinary infections. As researchers gained a deeper understanding of the biochemical mechanisms underlying stone formation, targeted therapies emerged, dramatically reducing recurrence rates and improving patient outcomes.

a. Pain management and symptom relief:

Pain management has always been a critical aspect of treating urolithiasis, particularly during acute episodes of renal colic caused by stone obstruction. The development of nonsteroidal anti-inflammatory drugs

(NSAIDs) such as ibuprofen and diclofenac in the mid-20th century provided effective options for managing the severe pain associated with kidney stones[131]. NSAIDs work by reducing inflammation and blocking prostaglandin production, which helps alleviate pain and relax the ureter, facilitating stone passage.

In addition to NSAIDs, alpha-blockers such as tamsulosin emerged in the late 20th century as an effective pharmacological option for facilitating the passage of ureteral stones. Alpha-blockers relax the smooth muscles of the ureter, reducing spasms and allowing stones to pass more easily[132]. A meta-analysis demonstrated that alpha-blockers significantly increased the likelihood of spontaneous stone passage, particularly for stones located in the distal ureter[133].

b. Alkalinizing agents for prevention and stone dissolution:

The development of pharmacological agents for the dissolution of certain types of kidney stones marked an important milestone in the non-invasive management of urolithiasis. In the mid-20th century, studies demonstrated

the effectiveness of alkalinizing agents such as potassium citrate in dissolving uric acid stones.

Uric acid stones form in acidic urine, and increasing the urinary pH to an alkaline range (6.5–7.5) can prevent their formation and facilitate their dissolution[134].

Potassium citrate became a cornerstone of treatment for uric acid stones and remains widely used to this day. Its mechanism of action involves neutralizing acidic urine, reducing stone aggregation, and inhibiting the

crystallization of uric acid. Long-term use of potassium citrate significantly reduces the recurrence of uric acid stones in patients with recurrent urolithiasis[135]. Additionally, potassium citrate was shown to be effective in managing calcium oxalate stones by reducing urinary calcium excretion and increasing citrate levels, which act as a natural inhibitor of stone formation.

c. Calcium regulation:

One of the most significant pharmacological advancements in preventing calcium-based stones was the use of thiazide diuretics. These medications were first developed in the 1950s for the treatment of hypertension but were later found to have a beneficial side effect: reducing urinary calcium excretion (hypercalciuria), a major risk factor for calcium oxalate and calcium phosphate stone formation[136]. Thiazides, such as hydrochlorothiazide, work by enhancing calcium reabsorption in the renal tubules, thereby reducing the amount of calcium available for stone formation.

The use of thiazides in patients with hypercalciuria and recurrent calcium-based stones became standard practice in the 1970s. Studies showed a significant reduction in stone recurrence rates among patients treated with thiazides compared to those receiving placebo[137].

d. Antibiotics for struvite stones:

Struvite stones, also known as infection stones, are formed urinary tract infections caused by urease-producing bacteria such as *Proteus* and *Klebsiella*. The discovery and widespread use of antibiotics in the mid-20th century had a transformative impact on the management of struvite stones by addressing the underlying infections that contribute to their formation[138].

By eliminating the causative bacteria, antibiotics helped prevent the formation of struvite stones and reduced the risk of complications such as recurrent infections and kidney damage. In addition to treating infections, antibiotics are often used prophylactically in patients undergoing surgical or minimally invasive procedures to remove struvite stones, thereby reducing the risk of postoperative infections.

IV. The 21st century: contemporary approaches to an ancient disease:

The 21st century has witnessed dramatic shifts in the diagnosis, treatment, and understanding of urolithiasis. The rapid progress of medical technology, coupled with advancements in molecular biology, has reshaped the way urologists approach urinary stone disease. With a growing emphasis on non-invasive treatments, personalized medicine, and improved prevention strategies, the 21st century promises further innovations in the management of urolithiasis. This chapter explores the key developments that have defined this era in urology.

1. Advances in the understanding of urolithiasis:

In the early 21st century, a greater focus on the molecular and genetic factors contributing to urolithiasis emerged. The pathophysiology of stone formation, once thought to be a simple consequence of dehydration or dietary imbalance, is now understood to involve complex genetic and biochemical interactions. Research into the molecular mechanisms of stone formation has provided critical insights into the various types of stones, their causes, and potential prevention strategies.

a. Genetic factors:

Genetic studies have uncovered numerous mutations associated with urolithiasis. For example, research on calcium oxalate stones, one of the most common types of urinary stones, has revealed that certain genetic mutations can disrupt calcium and oxalate metabolism, promoting stone formation. The calcium-sensing receptor (CaSR) gene is one such example. Mutations in the CaSR gene affect calcium homeostasis by altering the body's response to calcium levels in the urine. This disruption can lead to hypercalciuria, a key risk factor for calcium stone formation[139].

Furthermore, cystinuria, a rare inherited disorder caused by mutations in the SLC3A1 and SLC7A9 genes, leads to the excessive excretion of cystine in the urine, which can crystallize and form stones. This genetic condition is characterized by the formation of cystine stones, which are typically difficult to treat[140].

By analyzing the genomes of patients with recurrent stone formation, researchers have been able to pinpoint several new candidate genes involved in stone formation, such as those involved in ion transport, renal function, and crystal nucleation[141]. These findings have opened up new avenues for genetic screening and personalized treatment for high-risk individuals.

b. Biochemical and metabolic factors:

One of the key biochemical factors contributing to stone formation is the concentration of supersaturated ions in the urine, particularly calcium, oxalate, phosphate, and uric acid. When the concentration of these ions exceeds their solubility limits, they precipitate out of the urine and form crystals, which can aggregate to form stones.

The regulation of urinary supersaturation is heavily influenced by various proteins that inhibit or promote crystal formation. One of the most studied inhibitory proteins is Tamm-Horsfall protein (THP), which is secreted by the renal tubules and acts as a natural inhibitor of crystal aggregation. Low levels of THP have been associated with an increased risk of stone formation[142].

Another important molecule involved in stone formation is citrate, which acts as a natural inhibitor of calcium crystal formation. Hypocitraturia, a condition characterized by low citrate levels in the urine, is a known risk factor for calcium stone formation. Citrate binds to calcium ions, preventing them from crystallizing with oxalate or phosphate. In individuals with hypocitraturia, the lack of citrate leads to higher concentrations of free calcium in the urine, facilitating stone formation[143].

2. Advanced therapeutic approaches:

a. Personalized medicine and targeted treatment:

The concept of personalized medicine has gained traction in the treatment of urolithiasis. With advancements in genetic testing, urologists can now design customized treatment and prevention plans based on the patient's unique genetic makeup, medical history, and the specific characteristics of their urinary stones.

A significant breakthrough in personalized treatment for urolithiasis is the development of metabolic evaluations. Urinary stone disease is often associated with metabolic disorders such as hypercalciuria, hyperoxaluria, and hypocitraturia. Metabolic evaluations involve a comprehensive analysis of a patient's urine composition, including tests for calcium, oxalate, citrate, and uric acid levels. Based on these evaluations, urologists can prescribe tailored

therapies such as dietary changes, medications, and increased fluid intake to reduce the risk of recurrence[144].

b. Advanced treatment techniques:

The introduction of digital ureteroscopes with improved optical quality and working channels has enhanced stone visualization and retrieval. Single-use disposable ureteroscopes have addressed concerns about sterility and maintenance costs while providing comparable efficacy[145].

Modern variants of PCNL include mini-PCNL **(Fig. 41)** and ultra-mini PCNL. These techniques have been developed to reduce invasiveness while maintaining efficacy. These approaches use smaller instruments and access sheaths, resulting in decreased morbidity and faster recovery times[146].

Figure 41. A stone free mini-PCNL for a large staghorn stone, photo courtesy of the urology department in Tangier.

When it comes to ESWL, third and fourth-generation lithotripters **(Fig. 42)** have improved stone fragmentation while reducing tissue damage. Real-time ultrasound tracking systems have enhanced targeting precision, and modified shock wave delivery patterns have optimized stone fragmentation while minimizing renal injury

Figure 42. 4th generation lithotripter, photo courtesy of the urology department in Tangier.

The integration of robotic systems, particularly the da Vinci platform **(Fig. 43)** which was first introduced in 2000, represents a significant technological advancement in complex stone surgery. While not routinely used for standard stone procedures, robotic assistance has found its niche in specific challenging scenarios[147].

The primary advantages of robotic surgery include enhanced 3D visualization and improved instrument manipulation, particularly valuable in cases combining stone removal with reconstructive procedures[148].

Studies have demonstrated particular efficacy in simultaneous treatment of ureteropelvic junction obstruction with stone disease and management of stones in anatomically abnormal kidneys[149]. Meta-analyses show comparable stone-free rates between robotic and conventional approaches, with potential advantages in blood loss and hospital stay duration in select cases[150]. However, significant costs associated with robotic platforms remain a limiting factor, suggesting their optimal use in complex cases requiring concurrent reconstruction[151].

Figure 43. The Da Vinci robot, the surgeon is seated in the console while the surgical assistant manages the robotic arms [152].

3. Novel preventive strategies:

Prevention of stone recurrence remains a major challenge in the treatment of urolithiasis. In the past, prevention strategies primarily focused on fluid intake and dietary modifications. However, the 21st century has seen an evolution in prevention through both pharmacologic interventions and more advanced lifestyle counselling.

One of the key areas of development has been in the use of medications to prevent stone formation. For instance, potassium citrate has become a widely prescribed treatment for patients with calcium oxalate stones, as it helps increase urinary citrate levels and prevent crystal formation[153]. New medications targeting stone formation pathways have been developed. Novel therapeutic approaches include probiotic formulations, oxalate-degrading enzymes, and targeted molecular intervention[154].

Dietary modifications have also advanced with the help of genetic and metabolic profiling. Studies have shown that individuals with hyperoxaluria benefit from limiting oxalate-rich foods, while those with hypercalciuria may need to reduce salt intake. In some cases, individualized nutrition counselling has proven more effective than generic dietary guidelines in reducing stone formation risk[155].

In addition, advances in technology have enabled more effective monitoring of patients' hydration status. Mobile apps and wearable devices that track fluid intake and output allow patients to better manage their hydration levels in real-time, which is crucial in preventing stone recurrence. Such innovations empower patients to actively participate in their prevention strategies, improving long-term outcomes.

The following timeline **(Fig. 44)** concludes our work and illustrates the remarkable journey of urolithiasis through key historical milestones spanning from early antiquity to modern times:

Figure 44. Historical timeline of urolithiasis through key milestones

CONCLUSION

This work which came in the form of a literature review aimed to provide a comprehensive view on the historical journey of urolithiasis management, which stands as one of the most compelling narratives in medical history, illustrating humanity's enduring quest to understand and treat disease. From the rudimentary approaches of ancient civilizations to today's sophisticated interventions, this tale reflects not only the progression of medical science but also is a testament to the remarkable resilience and ingenuity of the Human species, trying to find solutions for an age-old affliction.

The evolutionary arc from ancient herbal remedies and primitive surgical techniques to contemporary minimally invasive procedures and targeted molecular therapies demonstrates the extraordinary depth of medical progress over millennia. This journey has been marked by several pivotal moments: the introduction of lithotomy in ancient times, the development of scientific understanding of stone composition during the Renaissance, the revolutionary impact of X-ray technology in the 19th century, and the paradigm-shifting introduction of extracorporeal shock wave lithotripsy in the late 20th century.

The epidemiology of urinary calculi has also undergone significant transformation from historical to contemporary periods. While bladder stones were predominant in medieval and early medical literature—often associated with poor hygiene, dietary constraints, and endemic nutritional deficiencies—the prevalence has dramatically shifted towards renal stones in the modern era. Contemporary epidemiological data indicates a substantial increase in renal stone incidence, attributable to factors such as metabolic syndrome, dietary changes, increased obesity rates, and improved diagnostic imaging technologies that enable more precise detection of smaller renal calculi.

Modern management of urolithiasis represents the culmination of knowledge gained through centuries of medical practice and scientific discovery. Today's approach, which combines sophisticated imaging technologies, advanced surgical techniques, and detailed metabolic evaluation, would have been unimaginable to the early practitioners who first documented this condition. This progression has taught us valuable lessons about the importance of balancing innovation with proven techniques, the value of cross-cultural medical knowledge exchange, and the critical role of technological advancement in improving patient care.

As we look toward the future, the field of urolithiasis management continues to evolve, with emerging trends in refining minimally invasive techniques, targeted preventive strategies based on genetic and metabolic profiling, and the emergence of artificial intelligence in diagnosis and treatment planning. The development of novel drug therapies, innovative delivery systems, and personalized medicine approaches suggests that we are on the cusp of another revolutionary period in stone management.

Yet, as we stand at the threshold of these new technological frontiers, the historical perspective reminds us that each advancement builds upon the foundations laid by previous generations of healers and scientists. The fundamental goal remains unchanged: to provide safer, more effective, and more accessible treatment options for patients suffering from this ancient disease.

The lessons learned from history will undoubtedly inform and guide future innovations, ensuring that progress in this field continues to benefit patients worldwide. This ongoing journey, spanning thousands of years of human history, reminds us that medical advancement is not merely about technological progress, but about the persistent human drive to alleviate suffering and improve the quality of human life.

ABSTRACT

ABSTRACT

Key words:

Urolithiasis · History · Lithotomy · Lithotripsy · Ureteroscopy · Extracorporeal Shock Wave Lithotripsy (ESWL) · Percutaneous Nephrolithotomy (PCNL).

Urolithiasis is a pathological state characterized by the presence of stones or calculi in the kidneys (parenchyma, calyces) or in the urinary tract (renal pelvis, ureter, bladder).

It is one of the oldest and most widespread diseases known to man, its history dating back to the dawn of civilization. The earliest references to urinary stones are mentioned in ancient Egyptian and Mesopotamian medical texts, and the oldest bladder stone was discovered in a mummy dating back approximately 4800BC.

The Greeks and Romans also documented urolithiasis; Hippocrates defined the symptoms of bladder stones and ways to treat it, so much so that 'cutting for the stone' is mentioned in the now staple Hippocratic oath. In ancient India, Sushruta was one of the first physicians to describe the surgical procedures for bladder stone removal, mainly perineal lithotomy.

During the Middle Ages, Islamic scholars such as Abulcasis and Ibn Sina integrated Greco-Roman knowledge and further expanded it, contributing to more refined diagnostic and therapeutic practices.

The anatomical studies of the Renaissance led to the emergence of surgeon anatomists and the development of more sophisticated surgical techniques.

During the period from the Renaissance up to this point, there was a revolution and a rapid increase in various fields that are related to this disease: X-ray technology, asepsis and anaesthesia to name just a few.

Recent advances in minimally invasive techniques, such as endoscopic procedures, and a deeper understanding of the biochemical and genetic factors influencing stone formation have further revolutionized the management of urolithiasis.

Urolithiasis historically was and still is one of the most prevalent diseases known to humanity. This study is a literature review that provides a historical overview that will shed light on the different vistas of civilizations in their approach to understanding and treating this age-old affliction ranging from the ancient Egyptian and Mesopotamian civilizations up to this day and thus make us better understand its management.

RESUME

Mots-clés :

Lithiase urinaire · Histoire · Lithotomie · Lithotripsie · Urétéroscopie · Lithotripsie extra-corporelle (LEC) · Néphrolithotomie percutanée (NLPC).

La lithiase urinaire est un état pathologique caractérisé par la présence de calculs dans les reins (parenchyme, calices) ou dans les voies excrétrices urinaires (bassinet, uretère, vessie).

C'est l'une des maladies les plus anciennes et les plus répandues dans l'histoire de l'humanité, son histoire remontant à l'aube de la civilisation. Les premières références aux calculs urinaires sont mentionnées dans les textes médicaux de l'Égypte antique et de la Mésopotamie, et le plus ancien calcul vésical a été découvert dans une momie datant d'environ 4800 av. J.-C.

Les Grecs et les Romains ont également documenté la lithiase urinaire ; Hippocrate a défini les symptômes des calculs vésicaux et les moyens de les traiter, à tel point que "la taille de la pierre" est mentionnée dans le désormais incontournable serment d'Hippocrate. Dans l'Inde ancienne, Sushruta fut l'un des premiers médecins à décrire les procédures chirurgicales pour l'ablation des calculs vésicaux, principalement la lithotomie périnéale.

Au Moyen Âge, les érudits islamiques comme Abulcasis et Ibn Sina ont intégré les connaissances gréco-romaines et les ont développées, contribuant à des pratiques diagnostiques et thérapeutiques plus raffinées.

Les études anatomiques de la Renaissance ont conduit à l'émergence de chirurgiens anatomistes et au développement de techniques chirurgicales plus sophistiquées.

Durant la période allant de la Renaissance jusqu'à nos jours, il y a eu une révolution dans divers domaines liés à cette pathologie : la découverte des rayons X, l'asepsie et l'anesthésie pour n'en citer que quelques-uns.

Les récentes avancées dans les techniques minimalement invasives, telles que les procédures endoscopiques, et une compréhension plus approfondie des facteurs biochimiques et génétiques influençant la formation des calculs ont révolutionné davantage la prise en charge de la lithiase urinaire.

La lithiase urinaire a historiquement été et reste l'une des maladies les plus répandues connues de l'humanité. Cette étude est une revue de la littérature qui fournit un aperçu historique qui mettra en lumière les différentes perspectives des civilisations dans leur approche de la compréhension et du traitement de cette affliction séculaire, allant des anciennes civilisations égyptiennes et mésopotamiennes jusqu'à nos jours, nous permettant ainsi de mieux comprendre sa prise en charge.

ملخص

الكلمات المفتاحية :

تحصي البول ،التاريخ ،بضع الحصاة ،تفتيت الحصاة ،تنظير الحالب ،تفتيت الحصوات بالموجات الصادمة (ESWL)، من خارج الجسم

(PCNL). استخراج حصاة الكلية عبر الجلد

يُعرف تحصي البول بأنه حالة مرضية تتميز بوجود حصوات أو ترسبات في الكلى (النسيج الكلوي،الكؤوس) أو في المسالك البولية (حوض الكلية، الحالب، المثانة)

يُعد هذا المرض واحدًا من أقدم وأكثر الأمراض انتشارًا، حيث يعود تاريخه إلى فجر الحضارة .تم ذكر أقدم الإشارات إلى حصوات المسالك البولية في النصوص الطبية المصرية القديمة وبلاد ما بين النهرين، كما تم اكتشاف أقدم حصوة مثانية في مومياء تعود إلى حوالي 4800 سنة قبل الميلاد

،كما وثق الإغريق والرومان مرض تحصي البول؛ حيث حدد أبقراط أعراض حصوات المثانة وطرق علاجها لدرجة أن "قطع الحصاة "مذكور في قسم أبقراط الذي لا يزال يُستخدم حتى اليوم .في الهند القديمة، كان سوشروتا واحدًا من أوائل الأطباء الذين وصفوا الإجراءات الجراحية لإزالة حصوات المثانة، خاصة عملية بضع الحصاة عبر العجان

خلال العصور الوسطى، قام علماء الإسلام مثل أبو القاسم الزهراوي وابن سينا بدمج المعرفة اليونانية الرومانية وتوسيعها، مما أسهم في تطوير ممارسات تشخيصية وعلاجية أكثر دقة

أدت الدراسات التشريحية في عصر النهضة إلى ظهور جراحي التشريح وتطوير تقنيات جراحية أكثر تطوراً خلال الفترة من عصر النهضة حتى الوقت الحاضر، حدثت ثورة في مجالات مختلفة مرتبطة بهذا المرض، مثل تكنولوجيا الأشعة السينية، والتعقيم، والتخدير، على سبيل المثال لا الحصر

أحدثت التطورات الحديثة في التقنيات طفرة في إدارة تحصي البول، مثل الإجراءات التنظيرية الباضعة الدنيا، بالإضافة إلى فهم أعمق للعوامل الكيميائية الحيوية والجينية التي تؤثر في تكوين الحصوات

لقد كان تحصي البول ولا يزال واحدًا من أكثر الأمراض انتشارًا في تاريخ البشرية .هذه الدراسة هي مراجعة أدبية تقدم نظرة تاريخية تسلط الضوء على وجهات نظر الحضارات المختلفة في فهمها وعلاجها لهذا المرض القديم، بدءاً من الحضارات المصرية وبلاد ما بين النهرين القديمة وحتى يومنا هذا، مما يساعدنا على فهم أفضل لإدارته.

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UNIVERSITÉ SIDI MOHAMED BEN ABDELLAH DE FES

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FACULTÉ DE MÉDECINE, DE PHARMACIE ET DE MÉDECINE DENTAIRE

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