

# Extraction of urinary bladder stone as described by Abul-Qasim Khalaf Ibn Abbas Alzahrawi (Albucasis) (325–404 H, 930–1013 AD)

## *A translation of original text and a commentary*

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### ABSTRACT

This is a detailed study of the technique of cystolithotomy as practiced by the Muslim surgeon Alzahrawi (Albucasis) in Cordova more than 1000 years ago. In addition to translating the relevant chapter in his book *Al-Tasreef*, his technique is critically evaluated comparing it with that of his predecessors and his successors. The study confirmed the originality of Alzahrawi who described operative steps and invented operative instruments not known in the Greco-Roman era. He was also the first to describe, in details, the operative technique in women and to recommend the 2-stage operation in complicated cases. His modifications and innovations greatly influenced surgery in Middle Ages Europe up to the 18th century which witnessed the beginnings of the modern method using the suprapubic, instead of the perineal, approach. Alzahrawi's influence is vividly seen in the practice of the Italian lithotomist "Marianus Sanctus" (16th century), the French "Jack De Beaulieu" (17th century) and the English "Sheldens" (18th century). Alzahrawi is the founder of lithotripsy. He introduced Al-Kalaleeb forceps to crush large bladder stones and Al-Mishaab to drill and fragment an impacted urethral stone. Andreas a Cruce (18th century) only added screw action to Al-Kalaleeb lithotrite but Amussat managed in 1822 to apply it transurethrally. Similarly, by the notion of transurethrally getting at the stone while within the bladder, Alzahrawi's idea of drilling by Al-Mishaab was the foundation of the litholepte of Fournier de Lempdes (1812), the instrument of Gruithusien (1813), Civiale's trilabe (1818) and the brise coque of Rigal De Galliac (1829).

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This new translation from Arabic is what the distinguished scholar and pioneer surgeon Abul-Qasim Khalaf Ibn Abbas Alzahrawi (Albucasis)<sup>1</sup> (325-404 H, 930-1013 AD) wrote on bladder stone extraction in the famous Thirtieth Article of his book "Al-Tasreef Liman Aajaz Aan

Al-Taaleef."<sup>2,3</sup> The detailed commentary that follows each consecutive part of the translated text critically evaluates the originality of Alzahrawi's operative techniques and studies its influence on the progress of surgery in Europe from Middle Ages up to the 18th century. It is to be noted that the superscript

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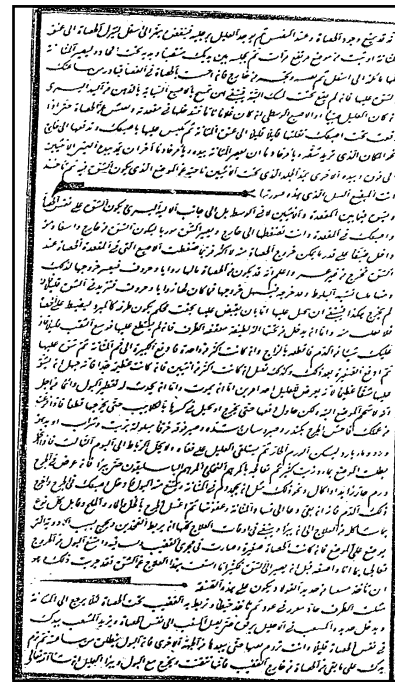
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numbering in the translated-text sections refers to the commentary, whereas in the commentary and in the figure legends the superscripts indicate bibliographical references.

**Chapter 60. On The Extraction of The Stone.** "I have already mentioned, in the "Classification",<sup>4</sup> the types of stones, their medical treatment, the difference between the stone borne [formed] in the kidney and the stone borne in the bladder together with signs of all of them.<sup>5</sup> I also pointed out that the need for operative intervention particularly arises in that stone formed in the bladder and that which gets impacted in the urethra. Hereby, I will briefly, but clearly, describe that technique".<sup>6</sup>

**Commentary.** 1. This distinguished surgeon Abul-Qasim Khalaf Ibn Abbas Alzahravi lived in the period from 325-404 H (930-1013 AD).<sup>1,3</sup> He was born and raised in Alzahraa, a suburb of the town of Qurtoba (Cordova) in Andalucia (now in Spain). It is narrated that his family tree was originally from Al-Ansar<sup>4</sup> (the supporters of Prophet Mohammad peace be upon him) of Al-Madina Al-Monawara, Kingdom of Saudi Arabia (KSA). He is known in the Western literature as Albucasis, Abulcasis, Bucasis (all being distortions of his Arabic "koniah"(nickname) Abul-Qasim) and as Zahravius; the Latin rendering of his Arabic birthplace name Alzahravi. He was the personal doctor of the Andalusian Caliph Abdul Rahman the Third (also called Abdul Rahman Al-Naser; meaning the victorious). Alzahravi was an innovative surgeon who added many original contributions to surgery and medicine, not known to his predecessors.<sup>2,9</sup> During his lifetime, doctors used to travel from far away places in order to learn from him. Later on, in Europe, he remained the famous teacher of surgery, during the Middle Ages and Renaissance, through his well known encyclopedic work Al-Tasreef Liman Aajaz Aan Al-Taaleef [The disposal of medical knowledge to he who is not able to get it by himself from the other compilations], particularly its thirtieth volume devoted to surgery and operative intervention. That volume is a landmark in the history of surgery being the first rational and complete illustrated treatment of its subject and the many surgical procedures and instruments described and illustrated in it do not appear in any other work of his time or before.<sup>2,9</sup> **Figure 1** is a copy of one of the pages of Chapter 60 of a manuscript<sup>10</sup> of that famous book showing the illustration of instruments together with the description of the related surgical procedure. In 1150 AD, Gerard of Crimona translated "Al-Tasreef" into Latin thus helping its spread in all Europe where it remained the most important reference book on surgery until the end of eighteenth century.<sup>3,5-8,11-14</sup>

2. Alzahravi stated that he gave his textbook the title "Al-Tasreef Limaan Aajaz Aan Al-Taaleef" "because of the frequent need of the doctor to look into it in all times and because he will get from it, in all aspects, what will keep him not in need of any other books."<sup>10</sup>



**Figure 1** - A page from Chapter 60 of a manuscript<sup>10</sup> of Al-Tasreef.

3. The original Arabic text for this translation was taken from the book "Al-Jiraha, Al-Maqala Al-Thalathoon, Al-Tasreef Liman Aajaz Aan Al-Taaleef by Abul-Qasim Khalaf Ibn Abbas Alzahravi edited by Abdulaziz Ibn Naser Al-Naser, Ali Ibn Sulaiman Altwaijri, 2nd edition, published in 1993 in Riyadh, KSA by Al-Farazdaq Press.

4. Alzahravi refers to the second article (Al-Maqala Al-Thaeneya) of Al-Tasreef devoted to the classification of diseases as well as their symptoms and treatment.

5. The concern for establishing the correct diagnosis is a continuation and further development of the efforts of the famous physician, Mohamed Ibn Zakaria Alrazi (Rhazes) (841-926 AD) who was the first to give prime importance to clinical observations and differential diagnosis.<sup>14</sup>

6. Extraction of stones from the urinary bladder is one of the oldest surgical operations in the history. The operation was carried out through a perineal incision down to, then through, the bladder neck to reach the stone and extract it. Comparing the description of the operative technique as carried out during ancient Indian civilization (Charaka in the first century and Susruta in the fifth century AD<sup>11</sup>) and during the Greek Civilization in Aegean Sea Greece (Paulus Aegineta, 625-690 AD<sup>11</sup>) with the description given by Alzahravi in this chapter, clearly shows how Alzahravi remarkably improved the technique of this operation and reduced its risk.<sup>4,11,13-14</sup> Alzahravi's modifications and innovations spread to Europe in the

Middle Ages and remained widely adopted until the beginning of the eighteenth century, which witnessed the beginnings of the modern method using the suprapubic, instead of the perineal, approach for the removal of bladder stones.<sup>1,5-6,11,13-14</sup>

*"I would like first to mention that this type of stone occurs mostly in boys. Among its symptoms is that the urine passes out of the bladder similar to water in its thin consistency with the appearance of gravel in it. The patient often keeps scratching, and playing with his penis that often dangles down then becomes erect and the rectum may prolapse in many of them. The cure of bladder stone is easy in boys up to the age of 14, difficult in the elderly and midway in between young men. The treatment is easier in the patient whose stone is larger whilst with a small stone it is the opposite of that."*<sup>7</sup>

*When we start to undertake the treatment, the patient, in the beginning, should have an enema to clear out all the stools from his bowel because it may prevent locating the stone during the search for it."*<sup>8</sup>

*Then the patient should be held by his legs and jarred to and fro and shaken downwards to bring the stone down to the bladder neck or, else, he could jump from a height several times. Then you seat him upright facing you with his hands beneath his thighs to make the whole bladder tilted downwards. Then you search him [for the stone] by palpating him externally.<sup>9</sup> If you feel the stone in the lumen,<sup>10</sup> cut upon it right away"*.

**Commentary.** 7. It is more difficult, whether using a scoop or a forceps, to blindly locate a small stone in the large bladder cavity.

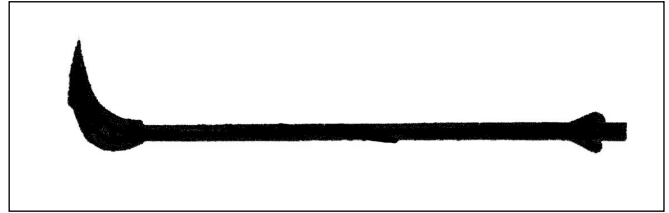
8. This preoperative preparation of the patient by an enema was not known in the Ancient,<sup>11</sup> Greek<sup>15</sup> or Roman<sup>16</sup> medicine. It was Mohamed Ibn Zakareya Alrazi (Rhazes) (841-926 AD) who first described it. In his book "Alhawi Alkabear" (The Continens) he says: "Because stools in the rectum may render palpating for, and locating of bladder stones is difficult or impossible, it is essential that the patient should be given an enema beforehand. When the bowels empty out its content, locating the stone, also the abdominal palpation, becomes easier."<sup>17</sup>

9. The suprapubic abdominal palpation. It is to be noted here that most of the patients during that period were young children in whom the urinary bladder is usually easily palpable in the abdomen because of their small pelvic cavity. In those days, also, the stones were usually large in size.

10. Meaning the lumen of the bladder.

*"But if the stones does not come at all under your (finger) touch, then lubricate, with oil, the left index, if the patient is a child, or the middle finger if the patient is a fully grown adolescent<sup>11</sup> and insert it into his anus and search out for the stone, until when it comes under your finger you move it little by little to the bladder neck. Then you press upon it with your finger pushing it outwards to the place where you wish to make your incision.<sup>12</sup> Request an assistant to squeeze the bladder*

*with his hand<sup>13</sup> and another assistant to extend away the testicles with his right hand and use his other hand to stretch the skin beneath the testicles away from the place where the incision will be made. Then you take the Al-Nashl scalpel whose picture is the following:<sup>14</sup>*



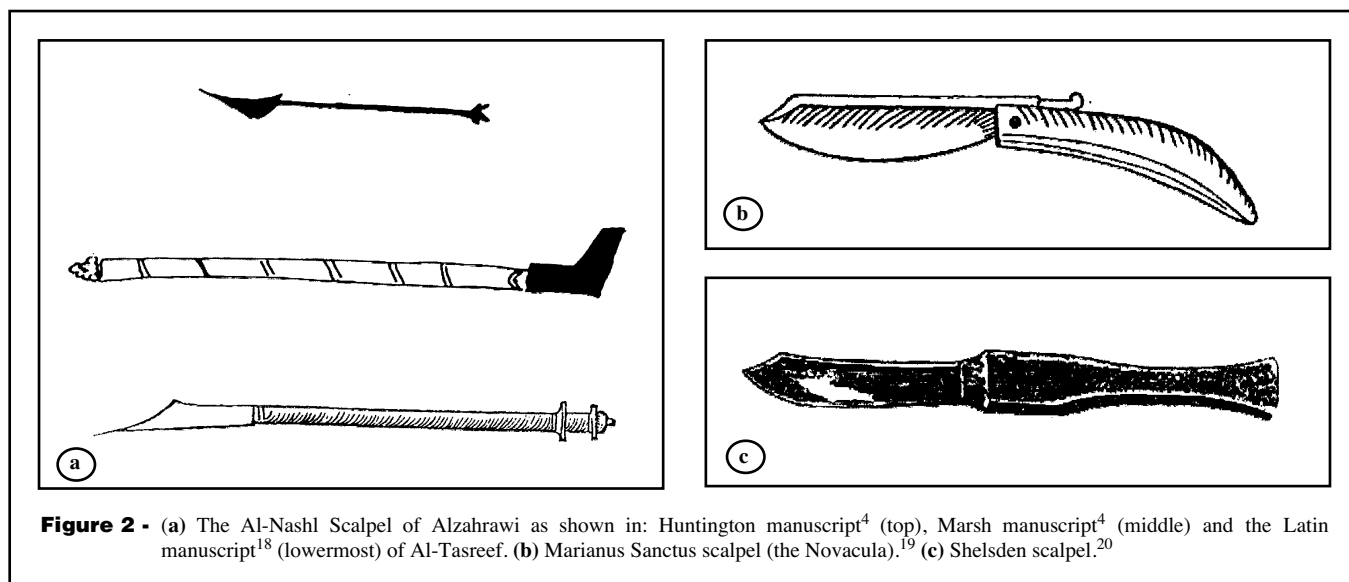
*and incise the area between the anus and the testicles not in the mid-line but to the side of the left buttock.<sup>15</sup> The cutting down is made directly on the stone itself while your finger in the anus is pressing it outwards. The incision is made oblique, wide externally but narrowing inwards to a size just enough to allow the exit of the stone, not larger, as your finger in the anus may have already pressed on the stone during the incision thus leading to its extrusion without difficulty"*.

**Commentary.** 11. Thus, the choice of the finger to be used for rectal examination is determined by the size of the anal orifice according to the age of the patient.

12. The perineum.

13. This is achieved by the assistant's hand pressing downwards on the supra-pubic area. Keeping the bladder squeezed will prevent the stone from dislodging away from the surgeon left index finger already situated in the rectum trapping the stone onto the bladder neck. The recruitment of an assistant to perform that step leaves the right hand of the surgeon free to perform the remaining steps of the operation. With the left hand of the surgeon occupied by the per rectal fixation of the stone, a second assistant is also needed to keep the testicles away and stretch the skin at the site of the incision (see the next sentence of Alzahrawi's text).

14. This scalpel is an innovation invented by Alzahrawi. It is different from the lithotomy scalpel which was in use during the Greco-Roman era<sup>4,15-16</sup> from the days of Meges of Sidon in the first century. Meges's scalpel was straight with 2 edges; an upper blunt thick and broad edge enabling the thumb to apply pressure on it, while the other (lower) edge was sharp, cutting and in the shape of a half circle.<sup>4,11</sup> Most probably Alrazi (Rhazes) used Meges's scalpel calling it "Al-Imadein" and giving more precise description of its shape: "incision is then made by Al-Imadein, which is not quite circular, in order to help it piercing



deep.”<sup>17</sup> Alzahrawi, however, invented a new lithotomy scalpel with 2 sharp cutting edges and, being a novel instrument not known before him; he made a drawing for it. The scalpel called "Novacula" used by the Italian surgeon "Marianus Sanctus" in the 16th century,<sup>11</sup> and the scalpel used by the English surgeon "Sheldsen" in the 18th century,<sup>11</sup> were very close in shape to Alzahrawi's scalpel (**Figure 2**).

15. In the ancient and Greco-Roman texts before Alzahrawi, there is no such emphasis on avoiding the midline incision. That innovation in the technique of perineal cystolithotomy, introduced by Alzahrawi, was of considerable practical anatomical significance. In Europe, during Renaissance, most of the well-known lithotomists such as the Italian "Marianus Sanctus" (16th century AC),<sup>11</sup> the French "Jack De Beaulieu" (17th century AC),<sup>11</sup> and the English "Sheldsen" (18th century AC),<sup>11</sup> were using Alzahrawi's lateral approach incising on the left side.

*"You should know that some of the stones might have angles and edges that make their extraction difficult. Some are smooth like acorns and rounded and, therefore, come out easily. In case of those with angles and edges, you need to slightly extend the incision. If still the stone will not come out then you should maneuver it either by holding it with a strong forceps having a rasp-like [serrated] end to get a tight hold of the stone so it shall not slip out,<sup>16</sup> or else you introduce underneath it a slender instrument with a curved end".<sup>17</sup>*

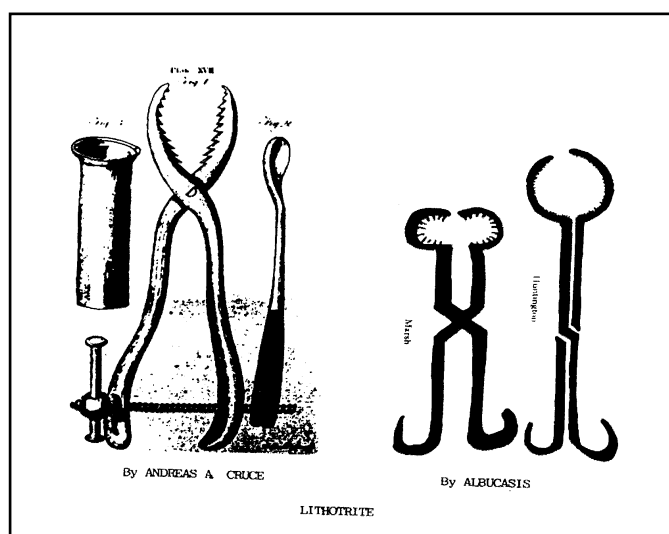
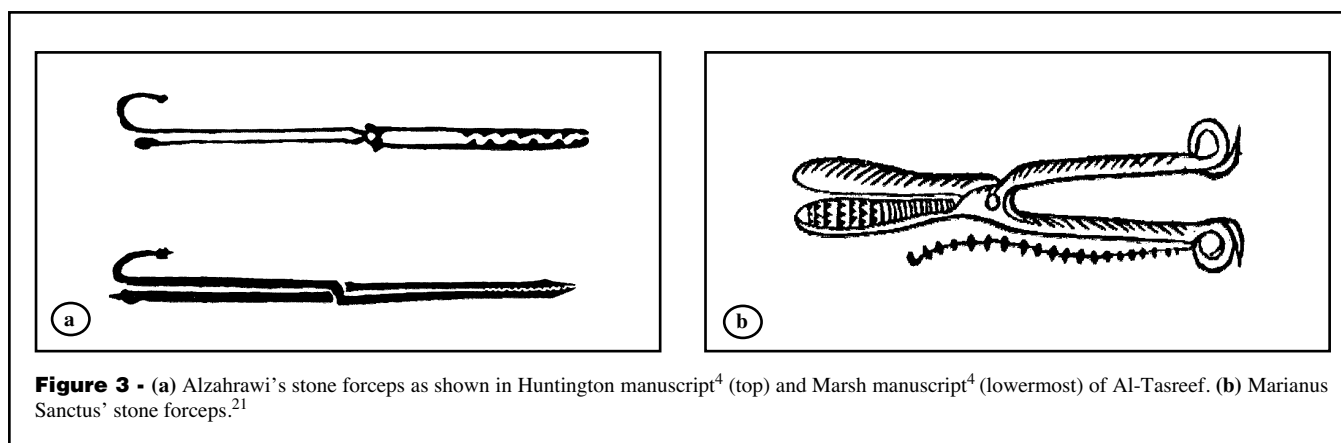
**Commentary.** 16. Alzahrawi was the first to use a forceps to extract a bladder stone. Before him, extraction of the stone was by an instrument similar to a small spoon that goes around the stone and scoops it out. Alrazi (Rhazes) used that spoon-like instrument and called it "Almajarra" (the dragger, the scoop). However, he also describe that, for dragging a stone out, need may arise to use the "Al-Kalbatain" which is

similar to the Arrows Extractor forceps. But Alzahrawi introduced, for that purpose, a new instrument with a better grasp on the stone. Accurate description of that new instrument and its use was mentioned in the text. The use of Alzahrawi's stone forceps spread to Europe during the Middle Ages and Renaissance. The drawing of the stone forceps shown in Marianus Sanctus book<sup>11</sup> (the middle of the 16th century) is exactly the same as the description and drawing of Alzahrawi forceps (**Figure 3**).

17. Most probably, this instrument is the scoop "Al-Majarra" described in the above commentary.

*"If you, still, cannot manage the stone out, widen the incision a bit; and if some bleeding disturbs you, stop it with vitriol. If more than one stone is encountered, first push the largest to the bladder neck, then you cut down upon it; then push the small stone next and continue doing the same if they are more than 2.<sup>18</sup> But if the stone is very large, it is utter ignorance to cut down upon, using a very large incision, because this will subject the patient to one of 2 outcomes: either he may die or suffer from permanent incontinence because the wound site will never heal. Rather you should try to manipulate the stone out or, else, maneuver breaking it with the Al-Kalaleeb so that you can deliver it out piecemeal".<sup>19</sup>*

**Commentary.** 18. These details on how to deal with multiple bladder stones were not mentioned in the works of the ancient or Greco-Roman scholars.<sup>11,15,16</sup> Before Alzahrawi, it was Alrazi (Rhazes) (841-926 AD) in his book Al-Hawi Fi Al-Tibb (The Continens), who first commented on multiple bladder stones. He even described a clinical physical sign to diagnose the presence of more than one stone on rectal examination before the operation: "and you detect that [presence of more than one stone] by your finger, as it will crackle thus you then know it."<sup>17</sup>



19. Alzahrawi is the first to describe a technique and an instrument to crush a large stone inside the bladder, thus, enabling its piecemeal removal. That innovation by Alzahrawi was an important landmark in the development and evolution of bladder stone surgery as it helped to decrease the mortality and morbidity of the operation. He vividly warned that it may result to death or permanent incontinence if a very large incision was resorted for extracting a very large intact stone. He condemned that procedure and considered it utter ignorance. Both Spink and Lewis<sup>4</sup> and Kirkup<sup>22</sup> considered Alzahrawi's innovation of crushing a stone inside the bladder, to enable its piecemeal extraction, as the foundation of the lithotripsy principle. They described his instrument Al-Kalaleeb as a primitive lithotrite. The technique attributed to Ammonius of Alexandria (? Second century BC) and described in Celsus book (? 50 BC)<sup>16</sup> (introducing a scoop behind a large stone and then a chisel-like instrument is driven

into the other side of the stone by the blow of hammer in order to split the stone) is not well documented. The famous book of Paulus Aegineta (seventh century AD), known to have summarized all previous Greek and Ancient medical and surgical knowledge, did not contain any mention of Ammonius or any technique of splitting or breaking up a large stone in the bladder.<sup>13,15</sup> On the contrary, it is documented that lithotomists, up to the fourth century AD, abhorred and warned against any attempt to fragment a stone inside the bladder before its extraction.<sup>13,15</sup>

It was Alrazi (Rhazes) (841-926 AD) who first doubted the belief, prevalent among the ancients that breaking of the stone inside the bladder during or before its removal endangers the patient's life. In his book Al-Hawi (the Continens), after citing that Antylus, the Greek (2nd century), adhered to that belief, Alrazi commented: "This is to be looked into, God willing."<sup>17</sup> However, Alrazi, realizing before

Alzahrawi, the dangers of resorting to a large incision to extract a very large bladder stone, described a technique in which the sides of the stone were made to protrude out through the small perineal incision, then they were pinched off, one after the other, with the Kalbatayn forceps which is similar to the Arrows-Extractor forceps; that repeated breaking away of the stone sides outside the bladder was continued until the stone became small enough to come out without the need to fragment it inside the bladder.<sup>17</sup> That technique of Alrazi was an important advance in the evolution of bladder stone surgery which was soon followed by the breakthrough innovation of Alzahrawi mentioned before. The use of Alzahrawi lithotrite Al-Kalaleeb spread to Europe during the Middle Ages and Renaissance; its impact on European Surgery remained until the eighteenth century. The lithotrite introduced by Andreas a Cruce in the early eighteenth century was, in fact, a modification of Alzahrawi lithotrite in which the manual compression on the handle was replaced by a screw action (**Figure 4**). However, instead of Alzahrawi forceps, Andreas a Cruce used the scoop to extract the fragments. The metallic cylindrical canula shown in **Figure 4** was used to control bleeding by inserting it in the perineal wound at the end of the operation.<sup>23,24</sup> Then in the 19th century more important modifications were successively added to Alzahrawi lithotrite when Amussat in 1822 managed to apply the principle transurethrally without the need to go through a perineal cystotomy.<sup>11,13</sup> Eventually by 1832, Alzahrawi principle of a pair of jointed serrated blades to crush (Al-Kalalib) was replaced by the modern principle of parallel non jointed blades, introduced first by Heurtlop and then rapidly developed to become the mechanism used in the modern lithotrites.<sup>11,13</sup>

*“And when you finish operating, pack the wound with frankincense,<sup>20</sup> aloes<sup>21</sup> and dragon blood<sup>22</sup> then bandage it tightly and cover it with layers of cloth soaked in oil and syrup or in oil of roses<sup>23</sup> and cold water to reduce the hot swelling.<sup>24</sup> The patient, then, lies flat on his back and do not remove the bandage until the third day. When the bandage is removed, spray<sup>25</sup> the area with plenty of water and oil; then treat it with palm ointment and basilicon ointment until it heals. If undue hot swelling<sup>26</sup> and spreading gangrenous suppuration<sup>27</sup> develops in the wound or anything similar, like blood clotting in the bladder causing retention of urine, the sign of which is the passage of blood with urine, then introduce your finger in the wound and evacuate that [clotted] blood; because if it remains inside it will lead to dysfunction and sepsis of the bladder. Then wash the wound out with vinegar, water and salt and apply, for each development, the appropriate treatment for until it heals. Also, it is essential, at all times during the application of treatment to fasten the 2 thighs and bind them together to keep in place the medications applied to the area”.*

**Commentary.** 20. The Arabic word used in the original text is *Kandar* which is the solid gum of a tree with the same name.

21. The Arabic word used in the original text is *Sabr*: which is the juice of *Sabbar* tree.

22. The Arabic word used in the original text is *Shian* (known also as *Dammul Alakhwain*).

23. The Arabic word used in the original text is *Dihnul Ward*.

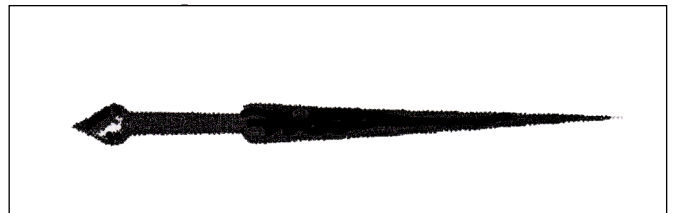
24. Hot swelling refers to the wound edema due to reaction to the physical inflammation.

25. The Arabic word used for the verb *spray* is the verb "*Nattal*" meaning used the *nattulat* which are medicinal compounds locally applied by spraying or rinsing in jets or as douches.

26. Undue hot swelling refers to excessive edema due to wound infection.

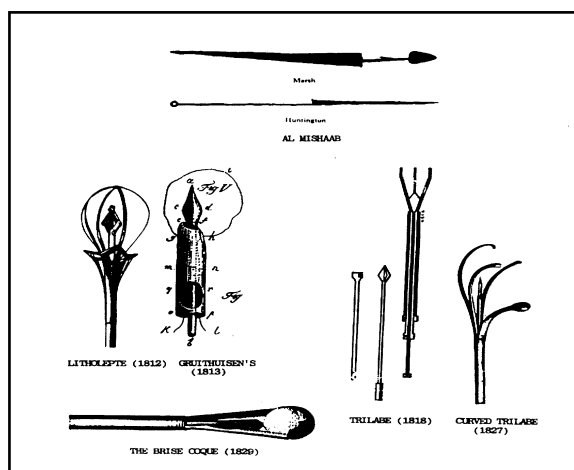
27. The Arabic word used in the original text is *Aakelah* which means *cancrum*.

*“And if the stone is small and moved to the penile passage and got impacted therein preventing the urine from coming out, deal with it in the way I am going to describe before you resort to cutting upon, for often with this treatment, I managed without the need to cut on the stone. I did try [have experience in] this [procedure].<sup>28</sup> Take a *Mishaab* [drill] made of *Foulaz* [stainless steel] with a shape like this:*



*Its end is triangular, and sharp and it is fixed to a wooden handle. Then take a thread and tie it around the penis below [ahead] of the stone so that it may not return back to the bladder. Then gently introduce the iron end of the *Mishaab* until it reaches the stone itself and then, with your hand, revolve the *Al-Mishaab*, little by little, upon the stone itself aiming at making a hole in it until you perforate through to the other side. Then, the urine will be immediately released. Then with your hand on the outside of the penis, squeeze what remains of the stone, it will crumble and be passed out with urine and the patient, Allah willing, will be cured”.*<sup>29</sup>

**Commentary.** 28. This statement confirms the wide personal experience and originality of Alzahrawi. It shows his ability to invent new instruments and introduce, and test, new techniques. Accordingly, he was not a mere compiler but also a very skilled innovative surgeon.<sup>3-9,11-14</sup>



**Figure 5** - The 19th century modifications of Alzahrawi's Mishaab to apply it on bladder stones.<sup>13</sup>

29. This procedure was not described by any of the ancient or Greco Roman scholars.<sup>11,15-16</sup> It is therefore, an original contribution by Alzahrawi. It laid the foundation for the principle of lithotripsy; an important landmark in the evolution of urology.<sup>4,6,23</sup> Alzahrawi procedure became widely recognized in Europe until the nineteenth century, which witnessed a period of ingenuity on the part of surgeons and surgical instrument makers. Therefore, by the notion of getting at the stone while actually within the bladder, Alzahrawi's idea of drilling by Al-Mishaab which was introduced in the bladder along a metal canula was the foundation of the litholephte of Fournier de Lempdes (1812),<sup>11,13</sup> the instrument of Gruithusien (1813),<sup>11,13</sup> Civiale's trilabe (1818)<sup>11,13</sup> and the brise coque of Rigal De Galliac (1829),<sup>11,13</sup> as shown in **Figure 5**. Then the final modification to Alzahrawi's idea of drilling was in the replacement of Al-Mishaab with a rotating burr as in Leroy d'Ettiole lithoprione (1822)<sup>11</sup> and Civiale's lithontripteur (1823).<sup>11</sup>

*"But, if this treatment was not feasible for you because of an impeding obstacle, then tie a thread below [ahead of]<sup>30</sup> the stone and another above [beyond];<sup>31</sup> then you cut down on the stone in the penis itself<sup>32</sup> between the 2 ligatures and deliver the stone out then undo the ligature and clear away the clotted blood that formed in the wound. It is a must to tie the thread below the stone so that it may not return to the bladder and the other ligature from above is needed so that when it is undone after removing the stone, the skin will return to its place and, thus, covers the wound. It is for that reason that when you tie the upper ligature you should pull the skin upwards so that, when you finish [the procedure] it will recede back and covers the wound as we just mentioned."<sup>33</sup>*

**Commentary.** 30. Meaning proximal to the stone (the side closer to the bladder neck).

31. Meaning distal to the stone (the side further away from the bladder neck).

32. Meaning in the penile shaft, cutting through the corpus spongiosum.

33. This point of technique aims at decreasing the chance of forming a fistula by avoiding incising the skin and the corpus spongiosum at the same level. It was described before by Paulus Aegineta in the sixteenth century AD.<sup>15</sup> However, Alzahrawi's description of the technique is different from that of Paulus who recommended pulling tightly on the foreskin then fixing it in that position by applying a ligature around it at the tip of the glans penis.<sup>15</sup> Contrary to the Greco Roman scholars, Alzahrawi was dealing with circumcised patients and this explains the difference in his technique from that described by Paulus. This again shows the originality and wide personal experience of Alzahrawi and confirms that he was not a mere compiler.

**Chapter 61. Stone extraction in women.**<sup>34</sup> *"It is uncommon for stones to form in women. And if it does happen to a woman the treatment is rendered difficult and is hindered for many reasons; first, the woman may be a virgin. Secondly, you will not find a woman who will expose herself to a [male] doctor if she is chaste or if she is one of his close relatives. Thirdly, you will not find a woman competent in this job especially in performing operations. Fourthly, in women, the site for cutting on the stone [the incision] is far away, from where the stone lies, so a very deep incision is required and there is a danger in doing that. So, if necessity compels you to such a situation, you should take with you a competent lady doctor, and she is, indeed scarcely found. So, if you could not find a competent lady doctor, look for an unblemished kind male doctor, or bring a midwife competent in looking after women or a woman who is knowledgeable to some extent about this art. So have her with you and request her to follow all your instructions in, first of all, searching for the stone. Thus, if she finds out that woman is virgin, she should insert the finger in her anus and feel for the stone. If she finds it and manages to trap it under her finger, then instruct her to cut down upon it. But, if she was not a virgin and was previously married then instruct the midwife to introduce her finger in the patient's vagina and feel for the stone after she has placed her left hand on the bladder and applied a good amount of squeezing pressure. If she finds the stone, she should roll it away from the bladder outlet in a downward direction as much as she can until the stone is pushed down furthest to the area where the thigh originates. And then, she should cut down upon it level with the mid point of the vulva at the root of the thigh, from whichever side convenient for her and enabling her to feel it; and her finger should never part with the*

downward push on the stone. And the incision is to be made small at first, then she is to introduce al-mirwed<sup>35</sup> [the sound] in the small incision and if she feels the stone then she will extend the incision as much as she knows it would allow the stone to extrude out. You should know that the stones are of many varieties: some are small and some are large; smooth and rough; oblong rounded and branched. You should know about these types so that you may have an indication of what to do. And if you are overcome by a hemorrhage, scatter powdered vitriol in the area and hold [keep] it there for an hour [for a while, for some time] until the hemorrhage has ceased then resume your operating until the stone is out. See also that you have made available, with you, those instruments I have informed you about in the extraction of stones in men in order to help you in your procedure. And if you are overcome by hemorrhage and you knew, from its being in pulses, that it is coming from an artery that has been severed, then put the powder on the area, band it up with tight bandages and leave it [undisturbed] and do not keep reexamining; leave the stone, do not extract it since this may cause the death of the patient. Then, manage the wound and when, after several days, the zenith of the swelling subsides and the area suppurates return back to your procedure until, Allah willing, you deliver the stone out<sup>36</sup>.

**Commentary.** 34. In the works of the ancient and Greco-Roman scholars, there is no mention of the technique of cutting on the stone in women. It is not reported in the book of Paulus Aegineta which includes a comprehensive summary of surgery from the ancient era until the author's time (sixth century AD).<sup>15</sup> Similarly, Alrazi (Rhazes) (841-926AD) did not discuss this topic.<sup>17</sup> Therefore, this chapter by Alzahrawi is considered an important original contribution to the progress of urology.

35. Al-mirwed is the name of the surgical instrument described by Alzahrawi for various uses in several chapters of his book Al-Tasreef. Consistent with those descriptions, al-Mirwed is a metal probe or a sound of so many uses. Before Alzahrawy, there is no previous similar mention of using it as a tool to confirm the presence of the stone before proceeding with the perineal cystolithotomy operation. Therefore, in agreement with Spink and Lewis,<sup>4</sup> this is another original contribution of Alzahrawi in this field.

36. Alzahrawi is, therefore, the first surgeon reported to introduce, in complicated cases, the 2-stages bladder stone operation. His teaching, based on his own experience, spread East and West and influenced surgery for several centuries. Covillard who recommended the 2 stage operation in the seventeenth century,<sup>11</sup> was in actual fact repeating the same advice of Alzahrawi.

In conclusion, this study confirmed that Alzahrawi (Albucasis) was not a mere compiler but also a very skillful, widely-experienced pioneering surgeon. His

original contributions remarkably improved the technique of cystolithotomy and reduced its risks. His innovations, including the Al-Kalaleeb and Al-Mishaab lithotrites, spread to Europe in the Middle Ages and remained widely adopted until the beginnings of the nineteenth century.

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