



Al-Zahrawi surgical instruments and techniques: a milestone in the history of surgery

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Abstract

Background and aims. Abu al-Qasim Al-Zahrawi (936–1013), known in Western literature as Albucasis, is recognized as one of the founders of modern surgery. Practicing in medieval Andalusia, he played a decisive role in transforming surgery into a systematized medical discipline. His major work, *Kitāb al-Taṣrīf*, a 30-volume medical encyclopedia, synthesized the surgical knowledge of his era and profoundly influenced European medicine for several centuries. The aim of this article is to examine Albucasis' contributions to the development of medieval surgery, focusing on instrumentation, and the educational influence of *Kitāb al-Taṣrīf* on European medical practice.

Methods. A narrative and historical analysis of open-access secondary sources was conducted, including the text of *Kitāb al-Taṣrīf* in medieval Latin translations, and modern academic literature indexed in international databases.

Results. Albucasis described advanced surgical procedures in pediatric, abdominal, orthopedic, and urological surgery and introduced more than 200 original surgical instruments, many of which became prototypes of modern tools. He emphasized the need to adapt operative techniques to the physiological particularities of children and highlighted the importance of clinical experience. The Latin translation of *Al-Taṣrīf* in the 12th century facilitated the integration of his principles into European universities.

Conclusions. *Kitāb al-Taṣrīf* remains a fundamental work in the history of surgery, and the principles formulated by Albucasis continue to influence medical education and modern surgical practice.

Keywords: Albucasis, Al-Zahrawi, Al-Taṣrīf, medieval surgery, surgery, surgical instruments, history of medicine

DOI: 10.15386/mpr-2963

Manuscript received: 09.01.2026

Received in revised form: 16.02.2026

Accepted: 19.02.2026

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Introduction

Abu al-Qasim Khalaf ibn al-Abbas al-Zahrawi (936–1013), known in Europe as Albucasis, is recognized as one of the most influential surgeons of the Middle Ages and as a founder of modern surgery. Born in Medina Azahara, near Córdoba, in Islamic Andalusia, Albucasis lived during a period of exceptional cultural and scientific prosperity, benefiting from the patronage of Caliph Al-Hakam II and having access to elite libraries and hospitals [1,2]. At that time, surgery was

regarded as an inferior discipline, often separated from theoretical medicine, and surgical practice in the Islamic world was affected by a lack of well-trained surgeons and by the absence of a systematized surgical tradition [3].

Medieval Arab (Islamic) medicine developed between the 8th and 14th centuries as a synthesis of Greco-Roman, Persian, and Indian medical traditions, enriched by original clinical observation and systematic scholarship [4]. Major centers such as Baghdad, Damascus, Cairo, and Córdoba hosted hospitals

(bīmāristāns), medical schools, and large libraries, fostering an environment in which medicine and surgery could evolve as scholarly disciplines [5]. Scholars such as Al-Razi (Rhazes), Ibn Sina (Avicenna), and Ibn al-Nafis contributed foundational works in internal medicine, anatomy, and physiology, while surgeons such as Al-Zahrawi elevated surgery from a craft to a scientifically grounded medical practice [6,7]. The translation movement from Arabic into Latin during the 12th century transmitted this body of knowledge to Europe, profoundly influencing medieval and Renaissance medicine and shaping the curriculum of early European medical schools [8].



Figure 1. Al-Zahrawi (Albucasis).

His major work, *Kitāb al-Taṣrīf*, represents a 30-volume medical encyclopedia encompassing internal medicine, pharmacology, obstetrics, dietetics, and, in particular, surgery [1]. The final volume is devoted exclusively to surgery and includes more than 200 illustrated surgical instruments, original operative techniques, and ethical and educational principles for physician training [3]. Albucasis introduced numerous innovations, such as the use of catgut for internal sutures, cauterization for hemostasis, specific instruments for tracheostomy and lithotomy, as well as the earliest descriptions of neurosurgical techniques and pediatric surgery [3,9]. The Latin translation of *Kitāb al-Taṣrīf* in the 12th century led to its adoption as a standard textbook in European universities, influencing Western surgery for nearly five centuries [3,10].

Study objectives: To analyze Albucasis' surgical innovations, and use of surgical instruments and to evaluate the educational impact of *Kitāb al-Taṣrīf* and on the evolution of European surgery and medical education.

Methods

This study combines a historical narrative review with primary source analysis and includes the surgical volume of *Kitāb al-Taṣrīf*, based on the critical edition with English translation by Spink and Lewis (1973). Secondary sources were selected from databases such as PubMed, SpringerLink, ScienceDirect, and Google Scholar and include historical articles and clinical analyses of Albucasis' techniques, instruments, and medical innovations. The analysis focused on identifying specific contributions in pediatric surgery, neurosurgery, urology, obstetrics, and general surgery, as well as the ways in which these innovations were adopted and adapted in European medicine.

Results and Discussion

This study shows that Albucasis systematized surgery within a structured educational framework, presenting detailed operative techniques, illustrated surgical instruments, and procedures applicable to both pediatric and adult patients [1]. His major work, *Kitāb al-Taṣrīf*, a 30-volume medical encyclopedia, includes one of the earliest comprehensive and illustrated surgical treatises, integrating Greco-Roman medical knowledge with medieval Islamic surgical practice and contributing to the transformation of surgery from an empirical craft into a structured medical discipline [3].

Albucasis introduced several major surgical innovations, including the first documented use of catgut for internal sutures and intestinal anastomosis, specialized instruments for tracheostomy, forceps for fetal extraction, lithotrites for lithotomy, and thermal cauterization for hemostasis [11]. His contributions to pediatric surgery were particularly notable for the period, encompassing descriptions of intracranial fluid evacuation in hydrocephalus, reduction of dislocations, and treatment of anal fistulas [1,12,13]. These observations demonstrate an early awareness of pediatric-specific anatomical and physiological considerations, which were rarely addressed in European surgery until much later [1,12].

Among Al-Zahrawi's most influential technical contributions is the documented use of catgut for internal sutures, particularly in intestinal surgery, anticipating modern absorbable suture materials by several centuries (Samir S Amr, 2007, Mehtap Pekesen, 2021). He also provided detailed descriptions of lithotomy for bladder stones using specifically designed instruments, emphasizing patient positioning and stepwise operative technique [14]. In hemostasis, he systematized the use of cauterization and ligation, offering precise indications for each method [15,16]. In obstetrics, he described forceps-like instruments for difficult deliveries and methods for managing retained fetal parts [17]. Furthermore, in neurosurgical and pediatric contexts, he reported procedures such as evacuation



Figure 2.



Figure 3.



Figure 4.

Figures 2, 3 and 4. Examples of surgical instruments described and illustrated by Al-Zahrawi (Albucasis) in *Kitāb al-Taṣrīf*, including instruments for cauterization, lithotomy, obstetrics, and wound management. These illustrations represent one of the earliest systematic visual catalogs of surgical instrumentation in medical history (adapted from Spink & Lewis, 1973) [19].

of intracranial fluid in hydrocephalus and treatment of anorectal fistulas, demonstrating an early awareness of age-specific surgical pathology [13,18].

A defining characteristic of Albucasis' surgical practice was its strong didactic and ethical orientation. He emphasized the importance of anatomical knowledge, operative prudence, and adherence to the Hippocratic principle of non-maleficence, advocating that surgery should be performed only by physicians with adequate medical training and anatomical expertise [2,3]. The detailed presentation of more than 200 illustrated surgical instruments provided a standardized and practical surgical repertoire applicable to diverse procedures, including fracture management, intra-abdominal surgery, pediatric interventions, and neurosurgical techniques [1,12].

The Latin translation of *Kitāb al-Taṣrīf* in the 12th century by Gerard of Cremona enabled the widespread dissemination of Albucasis' surgical principles throughout Europe. The text became a foundational surgical manual in medical schools such as Salerno and Montpellier and remained influential for several centuries [1,3]. Its impact is reflected in the extensive citations found in *Guy de Chauliac's Chirurgia magna*, which helped consolidate Albucasis' role [3] in medieval and Renaissance surgical education [3,20]. The adoption of internal sutures, illustrated surgical instruments, vascular ligation techniques, and pediatric and neurosurgical approaches in Europe can be directly linked to this transmission of knowledge [3,19].

Although Albucasis built upon earlier surgical authorities, including Paulus of Aegina, he significantly expanded their work through systematic documentation, clinical experience, and pedagogical clarity [21,22]. His

legacy positions him not only as a technical innovator but also as a key figure in the development of surgical education and professional ethics, with enduring relevance for the history of medicine and modern surgical practice [19,20]. Al-Zahrawi's work must be understood within the broader context of medieval Islamic surgery. Earlier and contemporary figures such as Paulus of Aegina (whose works were transmitted into Arabic), Al-Razi (Rhazes), and Ibn Sina (Avicenna) contributed significantly to surgical pathology, wound management, and clinical methodology [23,24]. Later authors, including Ibn al-Quff and Ibn Zuhr (Avenzoar), further refined operative indications and perioperative care. However, unlike these authors, Al-Zahrawi uniquely systematized surgical instrumentation and techniques in a single, extensively illustrated surgical treatise, thereby providing a practical and didactic manual that had no true equivalent in either the Islamic or Latin medical traditions of the time [25].

Conclusion

Albucasis made a fundamental contribution to the development of surgery in both medieval Islamic medicine and modern European medicine. Through *Kitāb al-Taṣrīf*, he systematized medical knowledge, introduced instrumental and procedural innovations, and promoted rigorous surgical training. His work had a lasting impact on medical education and surgical techniques in Europe, influencing practices that remain in use today. He demonstrated that he was not only a technical innovator but also a pioneer in surgical practice and medical didactics, whose legacy remains fundamental to the history of surgery.

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