The French Contribution to the Evolution of the Procedure and the Instrumentation for Lithotripsy

Marianna Karamanou, Anastasios Mylonas, Constantine Laios, and Effie Poulakou-Rebelakou

Lithotomy is one of the oldest recorded surgical techniques, although an early mention in the Hippocratic Oath states: "I will not cut, even for the stone, but I will leave such procedures to the practitioners of the craft."[1,2] A possible interpretation of the prohibition may recommend that only skillful lithotomists must involve with this delicate and dangerous surgical procedure.[3] Two approach routes were in use: the median perineal (Apparatus Minor) and the vertical (Apparatus Maior or Marian operation), both resulting at severe side-effects such as hemorrhage, pain, incontinence, impotence, and fistula. The latter was adopted by the famous family of lithotomists Collot in France, Jean Baseilhac (Frère Cosme), and Jacques Beaulieu (Frère Jacques) who was the inventor of the lateral lithotomy. Great lithotomists who followed the lateral procedure were Rau, Cheselden, and the majority of the pioneers in lithotripsy. Finally, Pierre Franco attempted a suprapubic approach (Apparatus Altus) in a 2-year-old child.[4] The difficulties of lithotomy led to the development of stone destruction into the bladder and extraction of the fragments through the physical way, baptized lithotrity, or lithotripsy (from the Greek noun "lithos" meaning stone and the verb "trivein" meaning to rub). The first effective for lithotripsy instruments were designed by 2 French surgeons, Jean Civiale (1796-1867), and Jean-Jacques-Joseph Leroy d'Étiolles (1798-1860), and made by the French Joseph Frédéric Benoît Charrière (1803-1876).

THE FIRST STEPS OF LITHOTRIPSY

Ammonius of Alexandria (third century BC) is considered the first person who invented a device, earning therefore the nickname "lithotomos" (stonebreaker).[5] Innovations were performed by Giovanni de Romanis in 1520, who invented the "itinerarium," consisting of a curved metallic sound holding a scalpel used initially for a wide urethretomy (method popularized by his student Mario Santo [1488-1577]) and also served as inspiration for lithotripters. Pierre Franco (1502-1560)[6] created an instrument with 4 jaws (quadrupulus vesicae), to remove stones transurethrally.[7] Ambroise Paré (1510-1590) invented also a bullet forceps (tire de balles),[8] and Santorio Santorio (1561-1636) designed a lithotripter consisting of a hollow tube and a central rod ending in 3 prongs and a cup (no record that it was ever used),[9] whereas Alphonso Ferri (1515-1595), professor of Surgery at Naples and Rome, invented and used an instrument called after his name the "Alfonsinum."[10] This was a 3-pronged pincer (with internal toothing) for the extraction of bullets from fire-arm wounds. The "Alfonsinum" was partly modified by Pierre Franco and transformed into a lithotrite, the model for the future instruments of the great French pioneers.[5,10]

THE FRENCH PIONEERS

After 250 years, François Fournier de Lempdes of Montpellier (1783-1843) constructed the "litholept," and Franz von Gruithuisen (1774-1852) introduced his "Steinbohrer" (stone drill) in 1813. Jean Zuléma Amussat (1796-1856) constructed also an instrument consisting of 2 jaws and a ratchet in 1817 and one more in 1822 (brise pierre à en dique tage).[8] In the same year, Leroy d'Étiolles introduced his "lithoprione" (wire-loop basket with rotating cutter) and his "litholabe" according to the bullet extraction principle of Alphonso Ferri and his "Alfonsinum."[8]

Jean Civiale (Fig. 1), French surgeon and lithotomist, was the first to carry out a successful transurethral lithotripsy on January 13, 1824, at the Necker Hospital in Paris. His first model (1817) had been modified by himself and by the instrument maker Joseph Frédéric Benoît Charrière (1803-1876)[7] of Swiss origins who has inserted a standard gauge system for use in medical equipment such as catheters and probes, today commonly referred to as "French sizing" (Fr) in the United States.[11,12] However, the relationship between the surgeon and the instrument maker was not always identical: accusations for disloyal behavior led to conflicts between Charrière

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From the Department of History of Medicine, Athens University Medical School, Athens, Greece

Address correspondence to: Effie Poulakou-Rebelakou, M.D., Ph.D., Department of History of Medicine, Athens University Medical School, Themidos 51, Athens 151-24, Greece. E-mail: efpoulrebel@med.uoa.gr

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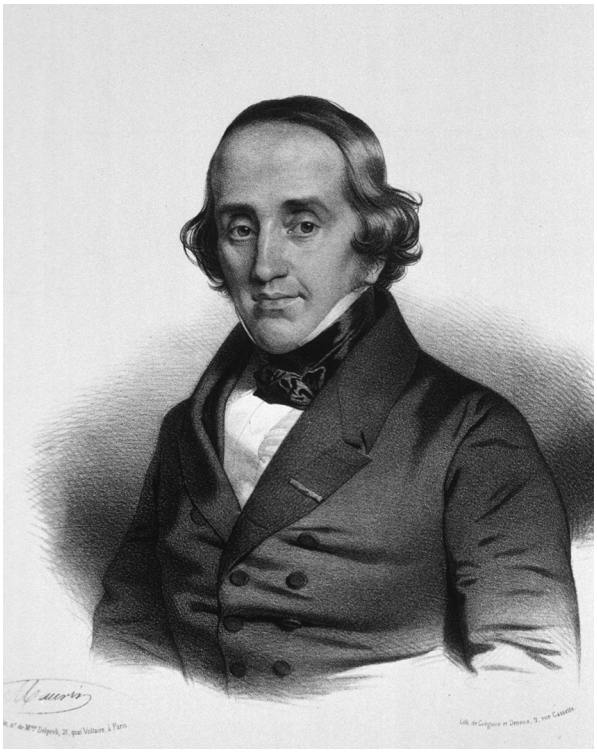

Figure 1. Portrait of Jean Civiale (1796-1867).

Figure 2. Lithotrite designed by Civiale.

and the 2 surgeons: Leroy d'Étiolles and Louis Auguste Mercier (1811-1882).[13]

The first idea of Civiale was to drill the stone and designed an instrument he called "trilabe" (Fig. 2), consisting of 2 tubes, one within the other, the outer to grasp the stone and the inner containing a drill to crush it. Civiale writes in his *Traité pratique et historique de la Lithotritie* (1847), "My preliminary experimentations and my operations on humans made me reject many instruments and various procedures, which at first sight seemed worthy, of confidence. These instruments and methods were adopted by all who came after me and were presented as new and superior than those already existing." He also adds, "It is not fair to resurrect ideas already overage and decorate them with new names believing that they are also new."[14] He later modified his trilabe to enhance the crushing ability and called it a "lithotrite."[9] Referring to the term "lithotripsy," he writes, "Even the name of lithotrity itself was transformed to more grammatically correct but more tough at the ear, lithotripsy."[14] As Civiale was becoming well known, the Parisian Hospital Administration allocated him several beds in Necker Hospital, thereby creating the first Department of Urology in Paris.[7]

Leroy d'Étiolles was not so much interested in operating. He added a bridge to hold the drill and the outer tube rigid and even tools to turn the stone and to regrasp it.[9] Baron Charles-Louis Stanislas Heurteloup (1793-1864) was both a lithotrite inventor and an operator. Although in London, in 1829, he performed the country's first lithotripsy and published his book "*Principles of lithotrity*." Describing his invention, "percuteur courbé à marteau" (curved crusher with hammer or percussion lithotrite), Heurteloup writes, "It is a simple steel rod destined to communicate a shock to the bottom of the shell…" One extremity is rough and the other one terminates in a ball of silver filled with lead (for more weight). A runner which by means of a screw can be fixed on any point of the rod constitutes the percuteur. The runner only allows the instrument to penetrate into the central canal of the principal forceps, far enough to strike the shell of the stone with sufficient power to reduce it into fragments, without however going so far through the tube as might prove harmful[15] and coined the term "lithotripsy" as the official name of the procedure.[4,8] His grinding lithotripter gripped the stone between 2 jaws and attacked it from outside, initially by a hammer and later by a screw, invented by Pierre Salomon Ségalas d' Etcheparre (1792-1875).[7]

Blind lithotripsy reached a high level in 1876, under narcosis by Henry J. Bigelow of Boston (1818-1890). His method of crushing the stone and evacuating the bladder from all the fragments using efficient catheters with aspiration balloons was named "litholapaxy."[8] He could operate for up to 2 hours and at the same time remove all the stone, instead of repeated sessions.[9] Using Bigelow's lithotrite as a model, Hugh Hampton Young (1870-1945) invented a cystoscopic lithotrite, in which the stone could be viewed inaugurating lithotriptoscope. Abraham Ravich (1889-1984) invented a visual lithotrite with a scissor handle for crushing the stone, very similar to that in use today.[9] Science brought physicians to a point not to "cut" the patients for stone disease, as the Hippocratic Oath forbid but rather manage them with minimally invasive activities.[16]

TWO ROYAL PATIENTS UNDERGOING LITHOTRIPSY IN ENGLAND

Henry Thompson (1820-1904) from England visited Paris in 1858 and learnt from Civiale the art of lithotrity performing it on 2 Royal patients: Leopold I of Belgium in 1862 and Napoleon III of France in 1872. The first came to visit his niece, Queen Victoria, and while in England was seized by colic due to bladder stone. Civiale was