

## **The History of the Pediatric Inguinal Hernia Repair**

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## **Extended Abstract**

The history of inguinal hernia repair is a rich one. For centuries, hernia healers, doctors, anatomists, surgeons and quacks have been devoted to this pathology that has afflicted mankind throughout its evolution.

The development of surgical correction mainly focused on adult pathology, with treatments that often involved the loss of the testis. Hernia management in children, however, also dates from antiquity. Described as a swelling on the surface of the belly in ancient papyri, it was treated with tight bandages by the early physicians of Alexandria. For centuries, conservative treatment had been used for the child using primordial trusses, many prayers, and often pagan rituals as the arboreal passage of children described by Marcello of Bordeaux, doctor of the Emperor Theodosius I (347-395 AD), reserving medical intervention only for cases of strangulation in which only reduction was attempted.

The middle ages were characterized by an increase in cultural and scientific exchange, during which the first comprehensive surgical textbooks and atlases were written. Different approaches the inguinal hernia were not taught and passed down through generations of surgeons.

The modern era brought a better understanding of the inguinal anatomy, which led to surgical techniques associated with less post-operative complications. Today, the pediatric inguinal hernia repair is one of the most common pediatric operations performed. It is considered a safe procedure with very low complication rate.

Key words: Inguinal hernia, pediatric hernia, history

## **Introduction**

The inguinal hernia has likely affected man since the assumption of the erect station, and children were not exempt. Until the 19<sup>th</sup> century, the approaches to treatment of the inguinal hernia in adults and children were very similar, although much more conservative in the child, where bandages were the most common practice together with pagan healing rituals. More detailed and accurate understanding of the anatomy and pathogenesis of the congenital inguinal hernia of children led to more successful surgical interventions in the 19<sup>th</sup> century. Today, the pediatric inguinal hernia repair is one of the most common pediatric operations performed. It is considered a safe procedure with very low complication rate. (1) This article presents the history of the inguinal hernia repair in 3 segments: Ancient Times, Middle Ages, and Modern Times.

## **Part one: Pediatric hernia repair in ancient times**

### **ANCIENT EGYPT**

In all probability, the first description of the inguinal hernia is in the Ebers Papyrus, written in 1550 BC, "... a swelling is seen on the belly surface ...outside ... provoked by the cough ...." The Ebers Papyrus recommended a diet and external compression of the hernia with bandages and liniments (palm oil). For Egyptian surgeons, all the hernias, except the inguino-scrotal variety, were treated non-surgically. The surgical approach to the inguinal-scrotal hernia, however, was excision of the hernia with orchiectomy. Strangulated hernias were considered inoperable. In fact, the Ebers papyrus attributes the death of Pharaoh Amenophis I to a strangulated hernia, despite the plasters and cathartics. The mummy of the Pharaoh Merneptah (1215 BC) had an incision over his inguinal region with one testicle removed, and the mummy of Ramses the 5th (1157 BC), had a huge hernia sac in the groin with a fecal fistula 2,3). (Fig.1,2)

In Alexandria, tight bandages were also used to treat inguinal hernia. This has been illustrated with the finding of a Phoenician statuette, dating from the year 900 BC, which shows a bilateral inguinal hernia treated with compressive bandages (4). (Fig.3,4)

### **GRECO-ROMAN TIMES**

With Hippocrates of Cos (460 - 377 AC), ancient Greek medicine emerged from the pre-scientific phase, linked to magical-religious practices and beliefs, and organized itself around a rational,

rigorous and scientific methodology. It is during these times that the first risk factors are identified, specifically certain professions: tailors, followers, blacksmiths, farmers, fishermen and riders.

According to Hippocrates, those who suffered from hernia were not apt to live long. Hippocrates also mentions inguinal hernias in children and differentiated between hernia and hydrocele, as the latter could be transilluminated.

Eliodorus (2 BC), from the School of Alexandria was the first to perform hernia surgery by separating the sac from the cord. He described the process as follows: "An incision is made up to the peritoneum, the margins of the incision are kept separated by hooks. An assistant pulls the testicle to one side while the operator carefully examines and separates the spermatic cord and stops the bleeding. The testicle is placed in the scrotum before removing the sac. The adhesions are treated and the intestines and the omentum are put back into place. The sac is lifted, twisted on itself and then cut ..." (5)

Claudius Galen (130 – 210 AD) is known as one of the most prominent physician of the Greco-Roman period. His understanding of anatomy and medicine was principally influenced by the then current humorism theory. His theories dominated and influenced Western medical science for more than 1,300 years. His anatomical reports, based mainly on dissection of monkeys remained uncontested until 1543, when printed descriptions and illustrations of human dissections were published in the seminal work *De Humani Corporis Fabrica* by Andreas Vesalius (12). Galen is credited with the first description of the patency of the processus vaginalis, the underlying abnormality leading to the development of congenital (indirect) inguinal hernia or hydrocele (176 A.D.). He correctly described the processus vaginalis as a "small offshoot of the great peritoneal sac in the lower abdomen." (6,7).

Interestingly, Galen believed that the watery fluid of the inguinal hernia or hydrocele was not a natural substance of the body. The surgical management of hydroceles depended on the size of the swelling and the age of the subject. In boys an incision is to be made in the groin, unless a large quantity of liquid prevents an inguinal approach. After isolation of the hernia sac, the humor would then be evacuated. In men, however, if there is a large amount of fluid, a scrotal incision is made.

At that time there was also a thriving school of pharmacology, based on the use of plants and chemical substances, led by Pliny the Elder (23-79 AD) and Pedanius Dioscorides (40-90 AD). Pliny recorded several pharmacological cures for hernias in infants: "Betony, too, is very good for hernia, applied topically or taken in drink..[and]..Juice of peucedanum is employed for hernia in infants. Ashes of burnt snails, applied with frankincense and juice of white grapes, are a cure for hernia [in infants], if applied for thirty days consecutively." Pedanius Dioscorides suggested the use of the

following recipe: “the rough leaf of Psyllium smeared on vinegar [applied locally with a compress] heals the hernias of children.” (8,9,10,11,12).

With the fall of the Western Roman Empire in 476, Byzantine medicine took over Greco-Roman medical traditions and the treatments of Galen, in particular. The first centuries AD were dominated by famous surgeons such as Soranus from Ephesus, Oribasius, and Paul from Aegina. Oribasius (400-450 AD) in the *Collectanea Medicinalia*, introduced the concept of cauterization, which created an inflammation of the wound and scar tissue. (13,14).

In Arabic medicine, Albucahis from Cordoba (936-1013AD) discusses hernia at length in ‘Maqalat’, acknowledging that early hernia swellings may reduce spontaneously, but mostly may become permanent through formation of adhesions. He advocated that hernias develop as a consequence of distension and weakening of the inguinal peritoneum and also believed in the surgical technique of cauterization (15).

Around that time, a sacred ritual (perhaps of earlier pagan origin) was reported by Marcellus of Bordeaux, physician of the Emperor Theodosius I (347-395). This was the arboreal passage for the healing of children affected by inguinal hernia. On the day of the feast of St. John or the Annunciation, after the religious ceremony, a branch of a tree, or a young tree, generally an oak, was split and the child passed through the opening, first by the head then by the feet. Two men held the crack open, through which a third, often one of the parents or the midwife, passed the sick baby. The ritual was performed three times, after which the ends of the branch were reunited and tied with a string. If the branch had sprouted again, the child would have been free from the disease and the rite would have been successful. This ritual was widespread throughout Europe and has persisted to the present day, documented by an Italian scholar, Giuseppe Bonifazio, recently in Noci near the city of Bari (16,17,18). (Fig.5)

## **Part two: Pediatric hernia repair in the Middle Ages**

During the middle ages, there was increase in cultural and scientific exchange through the Mediterranean port of Salerno, as evidenced by the arrival of Arabic and Greek texts. Under the leadership of Emperor Frederick II, there was significant growth and advancement in medicine and surgery in Salerno, led by Ruggero da Frugardo, Petroncello, Arcimatteo, Plateario, Ferrario and Rolando Capezzuti. The most famous medical books of the School Salerno, written by Ruggero da Frugardo circa 1170 was *Practica Chirurgiae*. In this text he states that “the peritoneum is the membrane that prevents the intestine from descending to the scrotum; often it is lapsed or only partly damaged. If the opening is small, only air passes, inflating the scrotum like a walnut, if instead

it is as large as an egg the intestine can easily descend along the inguinal canal and push the peritoneum on the testicles thus defining the hernia. If the opening is minimal or the patient is a child, attach a bandage over that point and pour a compress made of scarlet anagallis and the red of two eggs" (19).

One of the most prominent surgeons of the late Middle Ages, Guy de Chauliac (1300-1368), advocated advanced treatment of hernia from the era of barber surgeons. He proposed manual reduction of the hernia with the patient in Trendelenburg position or even hanging by the feet if necessary. He used laxatives, rest and rigorous diets to facilitate the reduction of the hernia. In his book, "Chirurgia Magna" (1363), Guy de Chauliac, described six surgical techniques for inguinal hernia surgery.

1. After skin incision, the hernia sac is transfixed and the distal spermatic cord with the testicle is amputated (method of Galen).
2. Cauterization of the external swelling with the red hot iron (method of Albucasis).
3. Scar formation by using a 'cauteriumpotentiale,' a plaster with escharotic capacity, for instance, arsenic (method of Theodoric of Cervia [1205-1298]).
4. Applying a transcutaneous suture around the spermatic cord, and tying it on an external wooden slat, until the cord becomes sectioned (method of Roger of Salerno [late 12th century]).
5. Incising the suprapubic area and introducing a hot iron cautery directly on the spermatic cord (method of Lanfranchi of Milan [?-1315]).
6. After incision, applying a golden thread around the spermatic cord, to tie it just enough to ensure closure of the hernia sac but without compromising the vascularization and function of the testis (method of Guy de Chauliac).

The surgical textbooks of Guy de Chauliac became the New Testament of surgery. For more than three hundred years, the different methods were in use, with a progressive preponderance for de Chauliac's technique with the "Golden Thread." Gold was recommended due to its ductility and poor reactivity. Once the hernia was reduced, the golden thread was carefully placed around the cord,

obliterating the hernial sac, but not so tightly as to devitalize the testicle. This technique was then popularized by French surgeon, Pierre Franco (1505-1578). (20-23)

There were some surgeons adamantly opposed to surgical correction, except for cases of strangulated or incarcerated hernias. Ambroise Paré (1510-1590) was one of those surgeons. In his treatise "On hernia care" he specifically cites children's hernias and states that because children are very prone to rupture, the best treatment consists of bandages, girdles, and tight ligatures that hold the intestine in place. After, the child will remain in his cradle for 30 - 40 days. Paré was opposed to the ligature "en bloc" of the spermatic cord with the sac during the surgical cure of inguinal hernias, and against the removal of the testicles. (24,25,26,27)

### **Part three: Pediatric hernia repair in the age of modern medicine**

The 18<sup>th</sup> century brought an influx of human anatomic knowledge, including groin anatomy. Jules Germain Cloquet (1790-1883) wrote a thesis based on the anatomic study of 340 hernias and 500 autopsies in 1819. He was the first to describe the iliopubic tract. Cloquet called attention to the frequency (20%) with which the processus vaginalis (PV) was found to be patent after birth, with diverse types of opening and depth of the peritoneal diverticulum (28,29). The surgeon and anatomist, Sir Astley Paston Cooper of England (1768-1841) was the first to describe the cremasteric fascia, the transversalis fascia, and the superior pubic ligament that bears his name.

In 1892, Henry Orlando Marcy (1837-1924 ) published his complete work, *The Anatomy and Surgical Treatment of Hernia*. The anatomic descriptions and illustrations in this monograph are worthy of study today, and clearly indicate that Marcy was thoroughly schooled in the contributions of Camper, Cloquet, Cooper, Hesselbach and Scarpa (30). In 1871, Marcy described high ligation of the hernia sac, placing attention to the narrowing of the internal inguinal ring. He wrote, "The problem is to reconstruct and narrow the canal. Nature must be our guide in its solution. The ureter in its entrance into the bladder permits the flow of the urine in only one direction. The more distended the bladder, the more firmly are the orifices closed. In like manner intra-abdominal pressure closes the normal inguinal canal." (31,32,33,34)

Introduction of anesthesia and antiseptic procedures constituted the beginning of modern hernia surgery, also known as era of hernia repair under tension (19th to middle 20th century). Three substantial rules were adopted to hernia repair technique: antiseptic and aseptic procedures, high ligation of hernia sac, and narrowing of the internal inguinal ring. In spite of this progress, the treatment results were poor as the recurrence rate was high and postoperative mortality reached 7%. It was only after the contributions of Bassini that results significantly improved. (35)

In 1882, Sir William Mitchell Banks (1842-1904) first described the technique of herniotomy that was often used in children, performed without incision of oblique muscle and external ring, but rather isolating the hernia sac outside the external ring. The technique that Mitchell-Banks proposed is the most favored procedure and suitable for newborns and infants, where the inguinal canal is short and inguinal rings are almost superimposed. With removal of the hernia sac through the intact external inguinal ring. In older children, with growth, the inguinal canal is extended and the Mitchell-Banks technique would be, from an anatomical point, less effective in achieving a high ligation according to the experience of some authors.(36,37,38)

The creator of modern hernia surgery was the Italian surgeon Eduardo Bassini (1844-1924). On Christmas Eve 1884, at the University of Padua, Bassini performed the first hernia repair based on the reconstruction of the anatomical planes (technique of the triple layer). Eduardo Bassini's "radical operation of the inguinal hernia" was developed and perfected from 1883-1887. In 1890, Bassini published successful results in 262 hernia repairs (39).

This new technique not only changed the approach to hernia repair, but also to inguinal surgery in general. Bassini's contribution was to focus on the posterior wall as the true repair site by approximating the internal oblique muscle, the transversus abdominis muscle, and the transversalis fascia with the iliopubic tract and the shelving edge of the inguinal ligament. This approach was used in children as well. Bull and Cooley, in their 1898 report, "Observation of the Hernias at the Hospital for Ruptured and Crippled" presented 371 cases of children under 14 years, operated on with Bassini's technique with only 3 recurrences. (40)

In 1899, Ferguson proposed hernia repair by exposure, dissection, simple high ligation and removal of the hernia sac. This was applied successfully to the pediatric population by Potts. (41) While in adult hernia repairs, the underlying principle involved reconstruction of weakened muscles and aponeurosis in multiple anatomical layers, for pediatric hernia simple dissection and high ligation of processus vaginalis at the internal ring was found to be sufficient to provide a long lasting cure to repair indirect inguinal hernias. The Ferguson principle still remains the basis of all pediatric hernia repairs even into the 21st century. At Boston Children Hospital, from 1915 to 1939, 4133 procedures with a modified Ferguson's technique were performed. They documented 10 recurrences. (42)

In 1941, William E. Ladd together with Robert E. Gross published the first textbook in pediatric surgery, "Abdominal Surgery of Infancy and Childhood," They described the Ladd and Gross technique which systematized the "open" pediatric inguinal hernia repair (43). This technique remains one of the most common surgical approaches to the pediatric inguinal hernia. The way in



which Drs. Ladd and Gross performed their inguinal herniorrhaphy was heavily influenced by the Mitchell-Banks operation. It consisted of the hernia sac being teased out through the external ring, ligation of the sac, and the excess sac is excised. The inguinal canal is not repaired. He notes, however, that this technique “would sometimes seem to be inadequate, particularly in those infants in whom the walls of the canal have been greatly thinned and stretched out by a large hernia mass.” For these patients, Gross and Ladd performed a Bassini repair to reinforce the floor of the inguinal canal. (44)

In 1982 Dr. Ralph Ger, at Nassau Hospital-New York, performed the first laparoscopic inguinal herniorrhaphy (45). He laid the foundations for a Copernican revolution of hernia treatment by completely shifting the treatment perspective from the high ligation of the sac and the reinforcement of the wall to the ligation at its origin in the abdomen.

The successes of adult laparoscopy ended up influencing pediatric surgery and, in particular, inguinal hernia surgery. The affirmation of laparoscopy was much more difficult because the open technique had achieved results equal to nearly 100% success. Gause and Co., 2017, showed that children  $\leq 3$  years of age, in their cohort, safely underwent laparoscopic inguinal hernia repair with similar pain scores, complications, and recurrence as compared to open repair. Parents and caregivers report high satisfaction with both techniques.(46)

## **Conclusion**

The evolution of the hernia repair has included changes in approach and technique ranging from non-invasive to maximally invasive. Sir John Brude of Edinburgh, former President of the Royal College of Surgeons of Edinburg once said that, “The final word on hernia will probably never be written,” which may very well be true. However, from the above history, we can appreciate two important undeniable concepts: One must have a solid understanding of the anatomic relations in order to perform a successful operation, and progress in surgery, comes from learning from failures.

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Part 1

- Fig 1. Man suffering from umbilical hernia. Tomb of Horemheb, last Pharaoh of the XVIII Dynasty. 1292BC, Wellcome Collection. CC BY
- Fig 2. Egyptian wall carving showing a probable reduction of groin hernia (left) and a circumcision scene (right), Saqqara, dated around 2500 BC. [Wellcome Collection](#). CC BY
- Fig 3. Thigh bandage for hernia in children. Ex libris, XVIII Century, Modified from Plate 22, showing treatment given to baby after birth. [Wellcome Collection](#). CC BY
- Fig 4. S. Mihles, The elements of surgery, 1764 Modified - bandages for inguinal hernia. [Wellcome Collection](#). CC BY
- Fig 5. Rite of arboreal passage in the South of Italy, the day of ST John. (Courtesy of Dr Pino Bonifazi)

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- Fig 6. Treatment of scrotal hernia. From Rolandus Chirurgia, a northern Italian manuscript circa 1300. (Courtesy of Casanatense Library)
- Fig 7. Caspar Stromayr: Sewing wound after herniotomy 1559. Notice: absence of the testis. Wellcome Collection. CC BY
- Fig 8. Portrait of Jules Germain Cloquet (1790 – 1883). Lithograph by Z. Belliard. [Wellcome Collection](#). CC BY
- Fig 9. Inguinal hernia: fifteen figures. (*Persistent patent processus vaginalis and its manifestations*) (Coloured lithograph by J. Maclise, 1851. [Wellcome Collection](#). CC BY)
- Fig 10. Marcy Technique
- Fig 11. Mitchell-Banks technique
- Fig 12. Atlas of Bassini technique by Attilio Catterina, Cappelli Ed Bologna. 1932 “The triple layer” (Courtesy of Cappelli Editor)
- Fig 13. Portrait of Alexander Hugh Ferguson (1853-1911) (Courtesy of InTech Open “inguinal hernia”, Chap.3 <http://dx.doi.org/10.5772/57158>)

- Fig.14. Ferguson technique (original drawing) to the courtesy of InTech open (“inguinal hernia”, Chap.3 <http://dx.doi.org/10.5772/57158>)
- Fig 15. Set of Ombredanne Mask. The "balloon" is obtained from a properly treated pig's bladder (Courtesy of Rocchini – Dumas Collections . Almenno San Bartolomeo (Bergamo-Italy)
- Fig 16. Original book cover of Louis Ombredanne “Précis clinique et opératoire de Chirurgie Infantile” 4eme Edition. Masson Ed. 1943
- Fig 17. Original book cover of Bernard Duhamel “Chirurgie du nouveau-né et du nourisson” Masson Ed. 1952
- Fig 18. Inguinal hernia technique of Dr Gross, reproduced from his original textbook. (to the courtesy /permission of Elsevier ed) Part 1
- Fig 19. Inguinal hernia technique of Dr Gross, reproduced from his original textbook. (to the courtesy /permission of Elsevier ed) Part 2
- Fig 20. Inguinal hernia technique of Dr Gross, reproduced from his original textbook. (to the courtesy /permission of Elsevier ed) Part 3
- Fig. 21. Laparoscopic inguinal hernia repair in children. Setting and cosmetic results( 5 mm transumbilical trocar , 3mm operative trocars) to the courtesy of InTech open (“inguinal hernia”, Chap.3 <http://dx.doi.org/10.5772/57158>)
- Fig.22. Laparoscopic inguinal hernia repair in children.Incision/removal of a small lateral portion of the sac to favour the healing of the peritoneum after the suture. to the courtesy of InTech open (“inguinal hernia” , Chap.3 <http://dx.doi.org/10.5772/57158>)
- Fig. 23. Laparoscopic inguinal hernia repair in children.Purse string suture of internal inguinal ring. To the courtesy of InTech open (“inguinal hernia” , Chap.3 <http://dx.doi.org/10.5772/57158>)
- Fig.24. Laparoscopic inguinal hernia repair in children. Closure of the purse –string suture of internal inguinal ring. to the courtesy of InTech open (“inguinal hernia” , Chap.3 <http://dx.doi.org/10.5772/57158>)
- Fig 25. Laparoscopic inguinal hernia repair in children. Sutureless technique in a girl with simple coagulation of internal inguinal ring by single trocar access(personal Photog)
- Fig 26. Various types of hernia trusses used throughout history: leather, metallic with restraint pad. Licensed from Alamy stock Photographs
- Fig.27 Chicago Tribune 19<sup>th</sup> Century. Advertising of electro-magnetic hernia truss.Licensed from Alamy stockPhotographs

