REVIEW ARTICLE

Historical approach to the surgical treatment of erectile dysfunction

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Abstract
Introduction: Throughout human history, erectile dysfunction has represented one of the most omnipresent health problems. This has resulted in a search for solutions that, one after the other, have been shown to be fruitless. In this context, the emergence of possible surgical solutions at the start of the 20th century represented a revolution that, even then, would take several decades to demonstrate their effectiveness.

Acquisition of evidence: We performed a literature review that shows the process in the development of potential surgical treatments for hormonal restoration for erectile dysfunction, followed by the sudden emergence of vascular surgery, with new anastomosis techniques, and in the future, the development of penile prosthetic implants as alternative treatments.

Summary of the evidence: The publication of results from erectile dysfunction surgery has been lagging for decades due to a lack of objectivity, given that sexual function is a topic restricted by patients' privacy. This situation has led to a reliance on results reported by various authors whose actual credibility could not be verified, with subsequent demonstrations showing that some of these results were not reproducible.

Conclusions: This article reviews some of the most important milestones in the progress of surgeries designed to treat erectile dysfunction. The achievements and apparent failures provide a reason for reflection on how far we have come and how far we can go in the near future.

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Aproximación histórica al tratamiento quirúrgico de la disfunción eréctil

Resumen
Introducción: A través de la historia de la humanidad la disfunción eréctil ha supuesto uno de los problemas de salud más continuamente presentes. Como consecuencia se produjo una búsqueda de soluciones que, una tras otra, se demostraban como infructuosas. En este contexto

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Introduction

The Ebers papyrus is often cited as the oldest text which mentions male erectile dysfunction, and it is also the oldest known treatise on therapeutics. It is estimated that this text from ancient Egypt was written in the period corresponding to the Eighteenth Dynasty (1550–1307 BC), and there we can read, in hieroglyphic writing, how impotence, symptomatically defined as penis weakness, can be treated with 37 plant products,1 which indicates how difficult it was at that time to find something really effective. Furthermore, 2 types of impotence are described: natural (age-related) and supernatural impotence (attributable to spells and incantations). An ointment made from baby crocodile hearts and wood oil is mentioned as a possible treatment in other Egyptian descriptions, which recommend the topical application of this mixture on the penis, thus trying to get a rigid erection.

It is striking that, at that time and with little anatomical knowledge, several treatment attempts were suggested, and that those ancient physicians refused to admit their complete absence of data to properly treat erectile dysfunction. Afterwards, in the 2nd century BC, the first anatomical dissections were performed first in the school of Alexandria by Herophilus, who dismissed many wrong ideas on human body functioning. Later, Erasistratus was even more expeditious in his desire to investigate, and he is said to have performed live anatomical dissections on criminals.2 This practice which now seems aberrant was performed within the legal framework established at that time. Thanks to this systematic research it became known that arteries were not filled with blood and air, contrary to the belief of Aristotle, who apart from his philosophical reflections, was also regarded as a great authority on anatomical knowledge, since he had dissected different species of the animal kingdom, reporting his findings in the works titled Historia Animalium and De Generatione Animalium.3 In those works he defended that erection occurred because the penis was filled with air through arteries. Although it sounds shocking now, the prestige of Aristotle as a man of science was so great that this idea was maintained as a reasonable hypothesis for several centuries, and it was not definitely rejected until the Dutch physician Regnier de Graaf showed, in the XVII century that erections could be induced in corpses by injecting saline into the penis thanks to the development of the first syringes and injection needles4 (Fig. 1). In order to solve any lingering doubt of whether erectile physiology was caused by an influx of air or haemodynamic contribution, he decided to prove, before an audience gathered for that purpose that the part of the erect penis of several dogs during withdrawal only showed the presence of a large amount of blood inside it, which was finally accepted as irrefutable evidence.

In light of these data, some brief notes on the beginning of the quest for knowledge about the physiology of erection and about possible treatments for erectile dysfunction, it is easy to assume that subsequent developments gave rise to much controversy. That constant eagerness to achieve greater scientific advances enabled major surgical and pharmacological developments that, eventually, took
place during the 19th and 20th centuries, thus reaching our current level of therapeutic possibilities.

**Hormone restoration surgery**

Since ancient times it has been known that testicles are the glands responsible for virilization and for maintaining sexual potency in males. Because of this, the harems of Muslim sultans and Ottoman pashas were guarded by eunuchs, males who had been castrated, thus losing their libido, and who became reliable individuals so that they were entrusted with the oversight of those women confined in those enclosed spaces. It is not surprising, therefore, that, as an attempt to regain sexual potency, among the aphrodisiacs available in different periods of our History, the idea of taking a dose of testicular extracts was contemplated. This type of treatment lies in the concept of organotherapy and basically consists of trying to restore the function of a damaged organ by ingesting similar organs. In ancient Rome, deer testicles were recommended for that purpose but, in different cultures, the provenance of animal gonads to which healing qualities associated with sexual potency and libido were attributed has been extremely diverse. The death of Ferdinand the Catholic is an example often used, since it was partly attributed to an excessive intake of bull testicles in order to achieve successful intercourse with his second wife and thus being able to have offspring again. The idea of performing the first hormone restoration surgeries arose from this way of thinking, which was maintained for centuries.

**Testicular transplantation**

The first testicular transplant in humans which we remember was performed in Philadelphia in 1911 by Levi Hammond and Howard Sutton. The receiver was a 19-year-old man who had been attacked at a testicular level. The donor was another young male who had died as a result of an accident. Not surprisingly, given the lack of knowledge of immune system functioning at the time, the transplanted organ was rejected, so this episode was quickly forgotten and was considered unsuccessful. Nevertheless, this fact drew the attention of Victor Lespinasse in Chicago, who encouraged prompt dissemination and acceptance of testicular transplants in the 1920s–1930s.

Lespinasse’s first transplant patient was a 33-year-old man who had the misfortune of losing both testicles independently. Thus, the first ever testicle transplant was performed in 1911, using the organs from a recent corpse, 3 months earlier than the Hammond/Sutton procedure, but he did not write about it until 1918. Rather than transplanting the donor testicle intact, Lespinasse grafted testicle slices in the scrotum and rectus muscle, arguing that these slices would more likely fuse to the existing tissue and not be rejected. According to his reports, 4 days after the operation the recipient reported a strong erection and checked out of the hospital highly satisfied. After a follow-up of several years, he decided to publish his results reporting that the man’s virility had remained intact.

While it is certainly possible that the patient thus treated experienced an increase in testosterone on the days following transplantation, given what we know today about immune system functioning, the expected effects would probably be short-term effects. In fact, Lespinasse himself had reservations about the long-term prospects of his procedure, and he later wrote that it was impossible to separate the effects of the testicular grafts from the “strong mental stimulus engendered by the operation.” However, he continued performing these procedures adopting a systematic working approach characterized by the fact that, believing that the more immediate the removal of testicles after death, the better the results, he tried to be notified when there was a suicide or an execution, thus appearing on site and removing the victim’s testicles while the possible receiver, who had to attend the health centre where he would be operated on, was being informed. The conviction with which he reported his results gave him credibility, and for some time he managed to lead this project before public opinion and the scientific community.

Almost at the same time, in Paris, Serge Voronoff, a surgeon of Russian origin, wrote about his technique to improve the results of testicular transplantation by using chimpanzee gonads. His technique was quite similar to that of Lespinasse, but that possibility of opening the gates to xenotransplantation gave a new aura of interest to his experiments, even setting a breeding centre for apes as a source of organs (Fig. 2). Misgivings concerning this procedure decreased and almost disappeared when Voronoff released his footage which showed several men who, allegedly after surgery, were practising various sports activities. In addition, Voronoff made it clear that the sexual functioning of his patients had also improved. For a period of about 15 years, nobody questioned these results, and he was imitated by many other surgeons, but, in 1929, Henri Velu conducted a retrospective analysis of those grafts performed by himself, observing them through optical microscopy, and found out that all of them showed characteristics of immune rejection.

**Deferral obstruction surgery**

In this same context, the Viennese physiologist Eugen Steinach10 proposed the ligation of the vas deferens as a technique to achieve a return of sexual potency by conducting experiments initially on bulls, rams and senile rats.
Afterwards, or the dures, physical postulated the obstruction remaining epithelium. testosterone, regarded vas obstruction due to Leydig cells hypertrophy. This idea arose, according to his own explanations, when he observed that, after cutting the vas deferens, his experimental animals seemed to extend their life span with increased physical vigour. Vasectomies performed for this purpose became known as "the Steinach operation" (Fig. 3). Later, this same author reported that, in addition, this procedure would be able to alleviate the symptoms of urinary obstruction due to prostatic hyperplasia, although this had already been published 40 years earlier, in 1893, by Reginald Harrison. Afterwards, a new study conducted at the John Hopkins Hospital was published as the first controlled study on the effectiveness of the ligation and resection of the vas deferens in rats. The authors did not find any significant difference in health parameters, with the exception of a slightly better muscular coordination of a temporary nature.

Vascular surgeries

With these procedures, he defended the hypothesis that, when a vasectomy was performed, testicles ceased the production of sperm due to the degeneration of the germinal epithelium. This caused, in a compensatory way, that the remaining testicular parenchyma increased its production of testosterone, due to Leydig cells hypertrophy. This idea arose, according to his own explanations, when he observed that, after cutting the vas deferens, his experimental animals seemed to extend their life span with increased physical vigour. Vasectomies performed for this purpose became known as "the Steinach operation" (Fig. 3). Later, this same author reported that, in addition, this procedure would be able to alleviate the symptoms of urinary obstruction due to prostatic hyperplasia, although this had already been published 40 years earlier, in 1893, by Reginald Harrison. Afterwards, a new study conducted at the John Hopkins Hospital was published as the first controlled study on the effectiveness of the ligation and resection of the vas deferens in rats. The authors did not find any significant difference in health parameters, with the exception of a slightly better muscular coordination of a temporary nature.

Dorsal penile vein ligation

Published results on the improvement of erectile dysfunction obtained through dorsal vein sclerosis led to the first ligation or resection surgeries at this level in the late 19th century. In 1902, Joe Wooten suggested, as a justification for this type of surgery, the hypothesis of "'atonic impotence'" claiming that it is the result of the loss of smooth muscle tonicity in the corpora cavernosa, resulting in dilated veins and sinuosity at that level. Later on, in 1908, the American urologist Frank Lydston published his results on 100 venous ligation procedures reporting that 50% of his patients were definitely cured and that the rest had improved their sexual function. Lydston claimed, as an explanation for these good results that he ligated not only the superficial dorsal vein, but also the deep dorsal vein of the penis, as well as collateral veins. According to his testimony, this caused accompanying penile tumescence, along with a sensation of enlargement of the penis which boosted the psychological confidence of patients in the effectiveness of this technique.

Penile arterial revascularization

Afterwards, as urologists embraced different techniques of vascular surgery and transplantation, attempts to resolve erectile dysfunction were directed towards the possibility of producing a greater blood supply through arterial revascularization techniques. Several authors are considered pioneers of this field. Prominent among them was Vaclav Michal, who provided different techniques such as direct revascularization of corpus cavernosum, by performing an anastomosis of the epigastric artery to the corpus cavernosum or an anastomosis of the inferior epigastric artery to the proximal stump of the dorsal penile artery, among other procedures. The results of these techniques were controversial, ranging from 38 to 79% of successful cases and losing effectiveness over a period of time. Instead, in the procedure proposed by Ronald Virag in 1989 the inferior epigastric artery is anastomosed end-to-side to the deep dorsal vein. This procedure was accepted for a time, but the potential risks of these techniques, such as glans hyperemia, spongy necrosis and hyperesthesia of the glands, could not be ignored. Magnifying lenses or microsurgery are required to properly perform these techniques, and given the unpredictability of long-term results they are questionable in most cases.
Penile prosthesis implantation

Without a doubt, penile prosthesis implantation surgery represents a great advance in the possible resolution of this problem for a significant number of patients, but the path to this point has not been smooth. The first attempt to restore penile rigidity by using any kind of autologous material was made by Nicolai Bogoras, who, in 1936, decided to use costal cartilage on a patient who underwent phalloplasty. Bogoras was inspired by the existence of a penis bone in many mammals. His experiment was not a success, since the cartilage was reabsorbed after a few months, but it did make it possible to objectify that its insertion was possible. Therefore, finding a rigid material which would not be rejected by the recipient’s body was only a matter of time.

The answer was eventually found on synthetic materials. In 1952, the surgeons Goodwin and Scott developed acrylic implants and placed them between the corpora cavernosa, but outside them, on 5 patients with relative success, according to their reports. This approach was replaced in 1960 after the complications and extrusions associated with this material were revealed. Afterwards, the development of polyethylene prosthesis marked a significant step forward reported by Beheri in Cairo. He inserted the new prosthetic cylinders into each corpus cavernosum with a Hegar dilator, which was used to create enough space for its insertion. In 1966, this author reported that he had operated on the largest series of patients up until that date, implanting that model of prosthesis on 700 patients. Since then, the technique continued to be improved in the 1970s with the introduction of silicone implants filled with spongy materials. The main problem was that, with these devices, the penis was in a constant erect state and the number of perforations remained uncertain. This was substantially resolved with the development of the prosthesis designed by Small and Carrion in 1975, which consisted of 2 silicone cylinders, soft and flexible, with a design adaptable to the anatomical structure of the corpora cavernosa, thus enabling their insertion inside them. In this way, it was possible to regain penile flexibility, but it did not enable penile flaccidity, since this prosthesis was always the same size. In spite of that, the easy implantation of these prostheses has led to substantial acceptance. Small and Carrion received a first place award for their work at the annual meeting of the American Association of Urology held that same year.

Nonetheless, the most sophisticated and nearly definitive step forward had already been improved in 1973, when Brantley F. Scott developed the three-piece inflatable prosthesis. Scott’s device, as first described, consisted of 2 silicone cylinders which were inflated with a subcutaneous pump located in the scrotum. This pump, through a valve mechanism, is able to deflate the cylinders, thus returning the liquid inside to a reservoir in the juxta vesical position (Fig. 4). This technological development has become a benchmark for erectile dysfunction therapy, and since then its use has continued to expand, while at the same time there have been technological improvements in the implantation procedure and in the protection of prostheses by adding an antibiotic coating to minimize potential infections.

Figure 4 Basic diagram of the first penile prostheses of 3 components.

Conclusions

As recently as a century ago, there was no indication about the future of surgery for restoration of erectile function. The first surgical attempts were directed towards the restoration of testicular hormonal function and, the destruction of intracavernosal tissue to enable the insertion of a prosthesis was not considered on the horizon of urology at that time. Similarly, nowadays it is not easy to guess future attempts to effectively treat erectile dysfunction, but the repair of damaged intracavernosal tissue may be closer than we ever imagined if techniques for regenerative cellular therapy continue their progress and take advantage of the patient’s multipotent cells as a new medication. Modern urology is expected to assume the research efforts required by the new and less invasive technological developments.

Conflict of interest

The authors declare that they have no conflict of interest.

References