Through Clinical Observation: The History of Priapism After Spinal Cord Injuries

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Key words
- History of neurosurgery
- Male priapism
- Spinal cord injury

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Citation: World Neurosurg. (2018) 109:365-371. https://doi.org/10.1016/j.wneu.2017.10.041

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

Since ancient times, physicians of antiquity noted the occurrence of priapism in some spinal cord injuries. Although priests saw it as a consequence of curses and witchcraft, after clinical observations of the Middle Ages and Renaissance, the first medical hypotheses emerged in the 17th–19th centuries completed and argued by neuroscience and neurology developed in the European laboratories and hospitals. This study aims to present a short overview of the history of clinical observations of posttraumatic male priapism after spinal cord injuries since antiquity until the beginning of the 20th century.

INTRODUCTION

Priapism has been observed and recognized as a pathologic condition since ancient times. Initially, it was found in sexually transmitted diseases and later it was observed in spinal cord injuries, and various superstitions and legends appear on its mechanism. The history of understanding the mechanism of this pathology and its neural mechanisms involved is relatively recent. At the end of the 18th century, based on clinical observations of priapism after spinal cord injuries, the first theories started to appear on its neural mechanisms.

From the first hypotheses formulated by ancient priests and the doctors in European hospitals in the 18th century, the idea that posttraumatic priapism (non-ischemic priapism) may appear in some spinal cord injuries, from foramen magnum to conus medullaris, took shape.[1] This study aims to present the history of clinical observations on this pathology, considered for a long time as being mysterious, and its evolution of the understanding and establishment of the neurophysiologic mechanisms involved.

OLDEST REFERENCES TO PRIAPISM: PREHISTORIC, ANCIENT, AND MEDIEVAL TIMES

Evidence of the existence of priapism dates back to the upper Paleolithic prehistoric period, 38,000–11,000 years ago.[2-4] The prehistoric people were impressed by this pathologic condition that had existed since the first days of humanity and drew it on the cave walls as a distorted enormous phallus, also being the first graphic register of urologic disorders.[2,5]

Edwin Smith Surgical Papyrus

Concerning priapism after spinal cord injury, the oldest reference dates back to 17th century BC in *Edwin Smith Surgical Papyrus*, the oldest discovered medical papyrus considered also to be the oldest known treatise on trauma.[6] This valuable ancient Egyptian medical text described a case of cervical spine fracture, associated with priapism and seminal emission, and also with quadriplegia and urinary incontinence. The title of this case was "Instructions on Dislocation in a Vertebra of His Neck," and it provided rigorous and detailed information on the clinical aspects of the disease:

> …if you examinest a man having a dislocation in a vertebra of his neck, shouldst thou find him unconscious of his two arms (and) his legs on account of it, while his phallus is erected on account of it, (and) urine drops from his member without his knowing it; his flesh has received wind; …it is a dislocation of a vertebra of his neck extending to his backbone which causes him to be unconscious of his two arms (and) his two legs. If, however, the middle vertebra of his neck is dislocated, it is an emissio seminis which befalls his phallus.[6]

Moreover, the Egyptian doctor knew that the prognosis was poor and hopelessly concluded: "an ailment not to be treated."[7] The accuracy of medical information mentioned in this papyrus made some people think that the author had actually been a great physician, anatomist, army surgeon, and also an architect, Imhotep.[8,9]

In Ancient Egypt, spinal fractures were quite common and occurred mainly after falls from heights of workers during the construction of Egyptian pyramids and temples.[10] Because during that time the information on the function and structure of the spinal cord was still primitive, in case of these accidents, Egyptian doctors made no difference between vertebral fractures and the presence of the underlying spinal cord injury,[11] preferring explanations shrouded in magic and superstition.[12]

Another piece of evidence of the early observations of ancient Egyptian physicians on male priapism associated with spinal cord injuries is found in the Egyptian scenes of beheadings of enemies. The

Figure 1. God Priapus illustrated in a fresco in the House of Vettii, Pompeii (public domain).

heliographic writings are symbols for scenes showing beheadings of animals, such as ox, ram, bubalis, goats, bovidis, and so forth, but mainly oxen sacrificed by the Egyptians in the opening-of-the-mouth ceremony described in funerary texts. These sacrifices of animals or beheadings of enemies were an opportunity for the Egyptian priests who were also *wab sekhmet* (physicians) to visualize the physiologic consequences of the destruction of the spinal cord and mainly of the cervical portion.[13]

Hippocrates of Kos (460–377 BC)

Adopting the previous theories of Egyptian and Greek civilizations, the physician and philosopher Hippocrates of Kos (460–377 BC) believed that the spinal cord was closely linked to male genital organs, creating a link between them. He thought that the spinal cord was connected to kidneys, ureters, and male genital organs by a special duct, and the sperm was produced within the spinal cord.[14-16]

Concerning the physiology of erection, Hippocrates thought that it was generated by the air and "vital spirits" flowing into the penis and that the testicles were connected to the penis through a pulley system of erectile cords facilitating the erection and their destruction affected penile erection.[17] Unfortunately, he could not verify his medical theories based mainly on observations because dissections were uncommon and unacceptable in Ancient Greece because of superstitions related to the violation of the human body.[18] Nevertheless, he noted that injury of the spinal cord produced paralysis and autonomous disorders, such as constipation or urinary disorders.[11]

Therefore, theories of Hippocrates on spinal cord injuries and their association with priapism remained based on clinical observations and unchanged until the Renaissance, when in 1477 AD, Leonardo da Vinci (1452–1519 AD) suggested a new mechanism for explaining erection and priapism after spinal cord injuries.

Galenus of Pergamon (129/130–200/201 AD)

In medicine, the term priapism was introduced by the last great physician of antiquity, Galenus of Pergamon (129/130–200/201 AD), being inspired by the name of the god Priapus (Figure 1). In Greek mythology, Priapus or Priapos was a *minor god*, god of fertility and male genitalia, and the protector of nature, small gardens, or vegetables that he protected from evil eyes or thieves that he threatened with sexual violence if they got closer to the guarded place.[19,20] The origin of the parents of this god is uncertain; some sources describe him as the son of Aphrodite and Dionysus,[21] and others as the son of Chione and Dionysus.[22] The legend says that goddess Hera cursed Priapus because he was in his mother's womb with impotency, ugliness, and foul-mindedness. Because of his ugliness, his mother Aphrodite disowned him at birth, leaving him on the banks of Hellespont at Lampsacus,[19] where he was found later by shepherds.

In iconographic pictures or statues, god Priapus was marked by his oversized, permanent erection. In a famous painting at the entrance of the House of Vettii in Pompeii, Priapus is shown in a posture of *anasurma* (exposing oneself), leaning on a pillar while using a scale to weigh his genital organ (Figure 1). At his feet, a basket of fruit and vegetables is shown, depicting him not only as the god of fertility but also the protector of gardens. In Latin texts, his huge penis was described as *terrible*, and even more than that, ancient physicians thought that

Figure 2. Nymphs and Satyr, Sterling & Francine Clark Art Institute Williamstown, William Adolphe Bouguereau, 1873 (public domain).

Priapus suffered from a pathologic erection.[19]

Galenus of Pergamon, in his treatise *On the Affected Parts*, described priapism and also tried to find a cure:

> …priapism is an increase in length as well as circumference of entire male organ without desire for sexual intercourse, and without some acquired heat which some people experience in the recumbent position. Some have outlined the condition as follows…a persistent, unchanging increase in size of the male organ or persistent swelling. It obviously has a name derived from Priapus. For human beings sculpt as well as pain Priapus as one who by nature has such an organ…And to treat priapism, apply the things that were discovered by experience to be naturally efficacious, namely give him [the patient suffering from priapism] yellow waterlily [nymphaia] to drink, the seed of the chastee tree and pale rue mixed with his food.[23,24]

Although Galenus confirmed the observations of Imhotep and Hippocrates regarding the neurologic consequences of cervical spine injuries,[25,26] an act of courage for that period was that he tried to find its cause and a physiopathologic explanation suggesting 2 theories: "the dilated orifices of the arteries" and "the formation of the pneuma in the nerve."[23] Galenus considered that cavernous bodies, which he names "hollow nerves," would attract the expanding *pneuma* (vital spirit) from the penile arteries that presented pathologic widening of vascular openings, and also with the aid of connected parts, such as veins and nerves.[27] His theory of air accumulation dominated ancient and medieval medicine until the Renaissance, when da Vinci issued a new theory.

It is a well-known fact that Galenus was the physician of gladiators in Pergamon, and there is no doubt that he had seen many times their spinal fractures. Unfortunately, they died quickly, also because of other associated lesions; therefore, Galenus did not have enough time to observe the evolution of spinal cord injuries associated with priapism. This may explain the fact that Galenus, as with most ancient physicians, such as Aretaeus of Cappadocia, Rufus of Ephesus, and Actius of Ameda, confused the term priapism with that of satyriasis,[28] a pathologic condition that he described in the following way: "some have meant by this tension in the sexual organs."[29] The last one (satyriasis) came from the word Satyr, a mythologic character that belonged to the category of nature demons, a hybrid creature, half man and half animal, a symbol of natural fertility and virility (**Figure 2**).[19,30] In fact, contrary to god Priapus, Satyrs were creatures who danced like goats or horses wishing to promote the fertility of a horse or goat.[31] They also gave the name to Satyr plays, a tragicomedy in Ancient Greece in which an important role was played by choruses of Satyrs that surrounded and served god Dionysus (Bacchus) in a party governed by drunkenness and sexuality.[32] Taking over the theories of Hippocrates, in which the erection and ejaculation mechanism was linked to the spinal cord, and not being aware of the difference between the 2 pathologies, Galenus suggested antiaphrodisiac medicine as treatment for priapism.

The theories of Galenus on the anatomy and physiology of the spinal cord from posttraumatic priapism were taken over by scholars throughout the entire Middle Ages to which were added just few insignificant details.

Paul of Aegina (Paulus Aegineta) (625–690 AD)

The Middle Ages marked the last of the great Byzantine physicians, Paul of Aegina (Paulus Aegineta) (625–690 AD), a Greek Roman encyclopedist and surgeon, considered one of the fathers of spinal

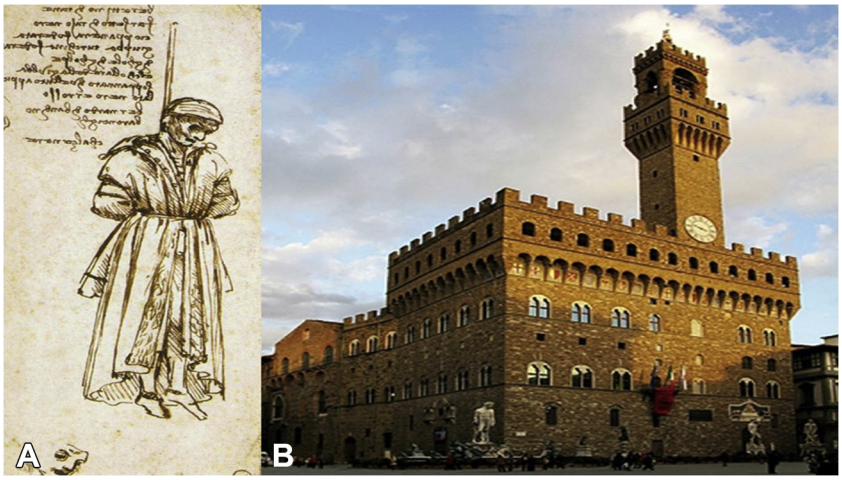

Figure 3. (**A**) Hanging of Bernardo di Bandino Baroncelli, Leonardo da Vinci, 1479. (**B**) Palazzo del Bargello from Florence (public domain).

surgery. He was the first to establish the difference between satyriasis and priapism, discussing them in 2 different chapters "On Satyriasis" and "On Priapism."[28,33,34] Paul of Aegina managed to do this because he was interested in all pathologies, including spinal cord injuries, and saw a link between spinal cord injuries and the appearance of priapism. He also recognized the risk of spinal cord compression that he described in his book, *The Seven Books of Paulus Aegineta*, translated into Greek in 1844 by Francis Adams.

DA VINCI'S AND AMBROISE PARE'S CONTRIBUTION TO UNDERSTANDING PRIAPISM

During the Renaissance, the genius da Vinci (1452–1519 AD) played a key role in medical history,[35] asking questions related to the erection mechanism and posttraumatic priapism after spinal injuries. If before da Vinci it had been believed that erection and priapism appear as a result of the accumulation of air in the penis, he opposed this idea by bringing solid arguments in this sense.[36-39] Also, at the beginning of 1477, when *il Maestro* witnessed the public hanging of Bernardo di Bandino Baroncelli, the murderer of Giuliano de Medici, he observed the priapism that was attributed by the authorities to the wind.[40] The scene of di Bandino Baroncelli's hanging was drawn later by da Vinci (Figure 3A).

Forasmuch as Florentine authorities allowed the dissection of the corpses of hanged criminals twice a year,[27] da Vinci had the chance to observe the postmortem examination, noting,

> "…I have seen…dead men who have the member erected, for many die like this, especially those hanged. Of these [penises] I have seen the anatomy, all of them having great density and hardness, and being quite filled by a large quantity of blood…If an adversary says wind caused this enlargement and hardness, as in a ball with which one plays, I say such wind gives neither weight nor density…Besides, one sees that an erect penis has a red glans, which is the sign of the inflow of blood; and when it is not erect, this glans has a whitish surface."[36]

Also called death erection or angel lust, priapism occurring in public hangings had been known, but its mechanism was not known, the inflation of penis with wind being suspected. The hanging of di Bandino Baroncelli was made from the window of *Torre Volognana* (the Palazzo del Bargello tower) in Florence (Figure 3B),[41,42] a palace that had been used as a prison and a place of execution until 1780 AD.[43] Considering that hanging was performed from a height of 57 m (187 ft),[44] we have reasons to believe that the mechanism was violent and lead to the brutal destruction of the cervical spinal cord with the secondary occurrence of priapism.

The medicine of the 17th century was dominated by Ambroise Paré (c.1510–1590 AD), a famous surgeon of the Renaissance who was the personal physician of 4 kings of France.[45] Considered also the father of modern surgery, Paré noted many cases of posttraumatic priapism and reached the same conclusion in 1573 as his forerunner da Vinci regarding the mechanism of priapism.[45] In his treatise, *The Books of Surgery*, the French surgeon also mentioned about spinal cord injuries, making some recommendations on the treatment of spinal fractures. Although in the 17th and 18th centuries anatomic dissections had been allowed and even flourished in Europe, knowledge on spinal injuries and on the appearance of priapism based on clinical observations was still primitive until the European School of Neurophysiology appeared 1 century later.

18TH AND EARLY 19TH CENTURY DOCTORS WHO CONTRIBUTED TO PRIAPISM ELUCIDATION

Clinical observations related to the appearance of priapism after spine injuries continued during the 18th and 19th centuries when the physicians from most important centers, such as Paris, London, Bologna, Edinburgh, or Leyden, began more often to look for the explanation of the mechanisms of this disease, being helped by newly discovered knowledge in neuroanatomy and neurophysiology that had started to shape the discipline of neurology in the hospitals and medical schools of Europe.[46]

Therefore, the French anatomist and army surgeon Baron Guillaume Dupuytren (1777–1835 AD), known as one of the most outstanding surgeons of his time and the one who treated Napoleon Bonaparte for hemorrhoids,[47] reported in 1847 a case of priapism associated with a cervical spine fracture.[48] Living in a period of the Napoleonic Wars and French Revolution of 1830,[49] Dupuytren consulted many cases of battle spine injuries at the

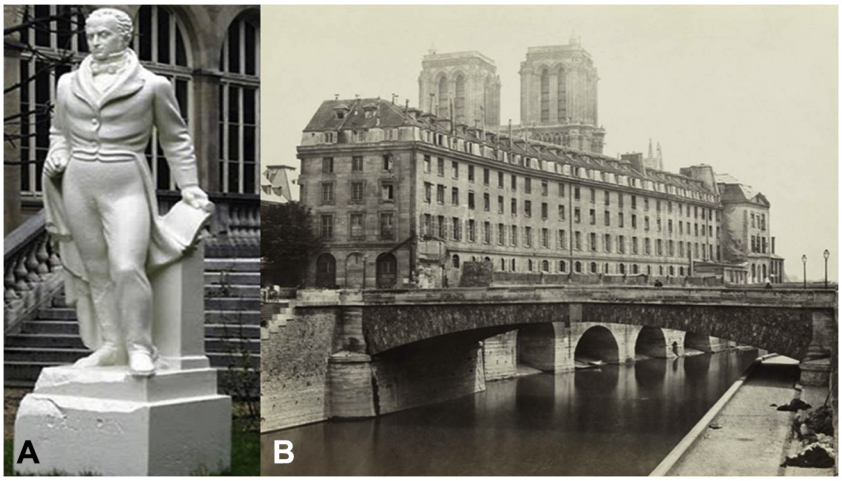

Figure 4. (**A**) The statue of surgeon Baron Guillaume Dupuytren (1777–1835 AD) in the inner yard of the Hôtel-Dieu Hospital. (**B**) Photograph of Hôtel-Dieu Hospital made by Charles Marville, 1865–1868 AD (public domain).

Hôtel-Dieu, the most famous hospital of the time in Europe, where he was the surgeon-in-chief (Figure 4). Therefore, in his paper, "On the injuries and diseases of bone," a collection of clinical lectures, Dupuytren published several cases of cervical spine fractures, among which the case of a 21-year-old man who fell from great height, which caused the fracture of the last 2 cervical vertebrae and associated priapism. Forty-eight hours after the accident, Dupuytren reported that the patient died without providing an explanation for a possible physiopathologic mechanism of priapism.[48]

There were several physicians in England who observed clinical priapism after spinal cord injury and mentioned it in their medical papers. Among these was the famous physiologist Robley Dunglison (1798–1869 AD), the Father of American Physiology and the personal physician of the President Thomas Jefferson,[50] who published several of his clinical observations at the Trinity College in Dublin.[51] He noted that priapism appears especially in injuries of the upper spinal cord, rather than the lower portion of the spinal cord, and that in most cases it is an early symptom, appearing in the second or third day after injury. Dunglison[51] also observed that priapism may be even induced to an unconscious patient by mechanical irritation of the penis, for example by the introduction of a catheter. In his book for students, *The Medical Student; or Aids to the Study of Medicine*, Dunglison defined priapism as a "constant and distressing erection," mentioning also the origin of its name from the ancient god Priapus.[52]

Interested mainly by bones and articulations diseases, the English surgeon and physiologist Benjamin Collins Brodie (1783–1862 AD), supported Dunglison's view that "priapism occurs even where the sensibility is entirely destroyed, and may be induced by the mechanical irritation caused by the introduction of the catheter, where the patient is entirely unconscious of the operation."[53] Brodie also noted that priapism may appear irrespective of whether the spine injury is produced by simple contusion or pressure, and also observed that priapism may be seen only in association with paralysis.[54]

Also during that period, another English surgeon and anatomist, Astley Paston Cooper (1768–1841 AD), known also for removing an infected sebaceous cyst from the scalp of King George IV,[55] described in his book, *A Treatise on Dislocations and Fractures of the Joints*, several cases of priapism that he followed daily.[56]

Although known more for his experimental activity, the English physiologist and physician Marshall Hall (1790–1857 AD) was interested also in clinical observations of priapism after spine injuries that he followed in his cases at the Royal Infirmary at Edinburgh, General Hospital at Nottingham, and later in London. In his book, *On the Diseases and Derangements of the Nervous System*,[53] Hall presented a letter from Professor Macartney from Dublin addressed to him, who told him about a case with priapism who fell in a quarry and injured his spine:

> …the erection of the penis was very violent immediately after the accident, and occurred at intervals for several weeks afterwards, especially on the slightest friction of the penis glans, creating much inconvenience at the introduction of the catheter. He was not aware of what was going on, unless he put his hand to the part, or looked at it. I have seen similar cases of erections after injury to the spinal marrow, but not in so extreme a degree; and I have observed a violent priapism in two men who were suffering death by hanging.[53]

Also, the Scottish surgeon Robert Liston (1794–1847 AD) reported at Pennsylvania Hospital the case of a man aged 30 years who fell from a height and had cervical dislocation of the fifth and sixth vertebrae, confirmed by the postmortem examination. The patient had priapism, which Liston stated "existed and continued constantly till the time of his death."[57]

All these surgeons focused on the area of their interest, not being concerned to discover the possible neurophysiologic mechanisms of posttraumatic priapism that they had noticed in cases of multiple injuries, except Hall, who became a landmark in the history of nervous reflex concept.

A Professor of Nervous Diseases at the University of Vienna, Moritz Rosenthal (1833–1889 AD) reported in 1879 in his book, *A Clinical Treatise on the Diseases of the Nervous System*, that cervical and thoracic spine fractures may be accompanied with priapism by temporary spermatorrhoea.[58] He presented the case of a brewer aged 43 years, who fell in a cellar whom he observed at the Vienna General Hospital, with a fracture of the lower cervical vertebrae and a continuous priapism for 7 days and even 36 hours after his death. The patient's postmortem examination was performed, and Rosenthal and his

colleagues mentioned that priapism was "due to traumatic irritation of the centre of erection, situated in the cervical and adjacent portion of the dorsal regions"; however, they argued that they were unable to confirm if priapism was because of an increase of the afflux of blood from paralysis of the vasomotor nerves or because of a functional irritation of the vasodilator nerves.[58]

Several years later, Alfred Goetz also noted the appearance of priapism in criminals during hanging and published in 1898 a book called *Über Erektion und Ejakulation bei Erhängten*,[59] in which he mentioned this pathology.

The 18th century marked the beginning of understanding of the neurophysiology of erection and priapism after spinal cord injuries noted by the Swiss physician, anatomist, and physiologist Albrecht von Haller (1708–1777 AD). He was the first to mention the existence of the possible neural mechanism in the physiology of erection and priapism. Therefore, von Haller argued that the erection mechanism appears as an increase of blood flow because of stimulation of the nerves.[60,61] von Haller refused to accept the theories of his predecessors stating that there is a fluid traversing the nerves and demonstrated that "the irritability" is a characteristic of muscle fibers and "the sensibility" is a characteristic of nerves.[27] He reached this conclusion after conducting 200 experiments on animals,[62] and he published these ideas in 1752 in his monograph, *On the Irritable and Sensible Parts of the Body*. The distinction made by von Haller between muscle irritability and nervous sensibility was an important step in understanding the physiology of erection and the mechanism of appearance of posttraumatic priapism after spinal cord injury.

His experiments became the foundation for studies in the second half of the 19th century related to the mechanism of penile erection. Dogs were the preferred animals in experiments, and few studies were conducted on rabbits and cats. Among the neuroscientists that laid the foundation for neurophysiology of priapism and erection, we should also mention Marshall Hall (1790–1857 AD), Jean Louis Brachet (1789–1858 AD), Jakob Henle (1809–1885 AD), Benedikt Stilling (1810–1879 AD), Claude Bernard (1813–1878 AD), Johannes Peter Müller (1801–1858 AD), Friedrich Leopold Goltz (1834–1902 AD), Ludwig Julius Budge (1811–1884 AD), Charles Brown-Séquard (1817–1894 AD), Conrad Eckhard (1822–1905 AD), Byrom Bramwell (1847–1931 AD), Walter Holbrook Gaskell (1847–1914 AD), John Newport Langley (1852–1925 AD), Hugh Kerr Anderson (1865–1928 AD), Ludwig Robert Müller (1870–1962 AD), Bronislaw Onuf-Onufrowicz (1863–1928 AD), and George Riddoch (1888–1947 AD).

CONCLUSIONS

Since antiquity, clinical observations of priapism after spinal cord injury have been the foundation for understanding this pathology considered for a very long time as being a mystery. With the development of neuroscience and neurology in Europe at the end of the 18th century and at the beginning of the 19th century, the first neural mechanisms were discovered and they contributed to the understanding of priapism after spinal cord injuries and also opened new horizons in the research of the neurophysiologic mechanisms of posttraumatic priapism occurrence.

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Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received 25 July 2017; accepted 9 October 2017

Citation: World Neurosurg. (2018) 109:365-371.
https://doi.org/10.1016/j.wneu.2017.10.041

Journal homepage: ***www.WORLDNEUROSURGERY.org***

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