

A developmental history of local anaesthesia

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Abstract

For thousands of years doctors have searched for a drug that could eliminate or at least ease the pain of surgery. Though the coca plant was well-known for more than 3000 years, it was not until the middle of the 18th century that the initial isolation of the organic base responsible for its extraordinary properties, cocaine, was accomplished. To the ophthalmologist Carl Koller goes the credit for the discovery of cocaine as a local anaesthetic. Since then, surgeons from all surgical fields adapted the newly discovered anaesthetic to all sorts of novel and complicated surgical interventions. Ambulatory surgery has benefited greatly from this development. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Throughout the centuries man has searched for an effective remedy against the pain caused by surgery. The frequent accidents and deaths brought about by anaesthetic techniques, discredited and eventually forced into retirement such ineffective methods as the soporific sponge.

Faced with this dilemma and, bearing in mind that most interventions were carried out on the extremities or on the skin, surgeons tried to alleviate pain by means of a local anaesthetic.

From the times of Arabic dominance in medicine, compression of arms and legs met with partial success. This practice gained further momentum during the Renaissance. In 1664 Severino, relying on ice and snow, was able to improve the analgesic effects of compression. Bartolino in 1667, and later on, the English surgeon John Hunter (1728–1793) and the chief surgeon Dominique Jean Larrey (1766–1842), successfully used this technique on many patients. The latter became Napoleón's surgeon in 1807. He performed amputations under extremely cold temperatures (-24°C)

However, it was not until 1848 when this practice was thoroughly revolutionized. The merit belongs to James Arnott (1797–1883) who, in 1845, made reference to the use of cold as a means of inducing insensitivity during surgical procedures [1]. In this work he introduced an apparatus of his own, which consisted of a spray filled with ice and salt. Used in the beginning to alleviate pain, Arnott defended its application with these words. "... in all superficial operations, which constitute the immense majority, cold is superior to chloroform in the circumstances of safety, ease of application or the saving of time and trouble, certainly of producing anesthesia, and lastly, in the power it possesses of preventing subsequent inflammation" [2].

In 1866, Benjamín W Richardson (1828–1896), who years before had failed with his invention called 'Voltaic Narcotism', described his 'Ether Spray'. This was predestined, because of its simplicity and cleanliness, to supplant the Arnott method [3]. The ether spray became the only local anaesthetic available until the introduction of cocaine 18 years later.

2. Cocaine

The coca-plant's stimulating effect on the organism has been well-known for more than 3000 years [4]. Some historians have suggested that the natives used

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coca as a local anesthetic in the surgical procedure of trephination. They obtained it by chewing the leaves and pouring the resulting salivates into the incision. Moreover it is known that the Inca used coca as an analgesic for muscular pain, headaches, toothaches, rheumatism, skin ulcers and gastric disorders [5].

The Spanish conquerors shied away from using coca at the beginning, thoroughly convinced that it was a part of pagan rites. However, a few years later, impressed by its value as a stimulant, they went on to encourage its cultivation. In 1580 Monardes of Seville passed on the information about its properties to the mother country. Contrary to the popularity of tobacco, which was fully accepted in Europe after the first historical trip by Christopher Columbus, coca remained unknown.

In 1750 the botanist Jussieu sent a plant specimen to Lamark who classified it with the name of erythroxyllon coca. In 1853 Mackenroder took up the chemical investigation of coca. In 1855 the German chemist Friedrich Gaedeke isolated an alkaloid from its leaves which he denominated erythroxylline. However, it was not until 1857 when Professor Wöhler of Gottingen appealed to the naturalists of the Novara expedition for a supply of dried coca leaves that a thorough investigation of coca commenced. Dr Scherzer, one of the scientific members of the expedition, managed to purchase 25 kg of coca in Lima and dispatched 15 kg of this valuable booty to Wöhler. Wöhler's assistant, Albert Niemann (1834–1861), conducted an investigation on the supplied leaves and consequently was able to purify and crystallize its organic base which he called cocaine. Even though the possible existence of other chemical components in the plant or its physiological actions were ignored, Niemann was keen enough to report the numbing effect of the newly synthesized substance.

Apparently in 1856 Samuel Percy (1816–after 1890) mentioned the possibility of using coca leaves in anaesthesia. The anthropologist Paolo Matengazza (1831–1910) who had spent many years among Indians and experimented with coca, supposedly said: “I requested to be pinched and the pain I felt was only barely perceptible.” [6]. In 1862, Demarlé and Schroff confirmed the same observation and in 1868 Thomas Moreno y Maiz, surgeon of the Peruvian army, published the first study on the pharmacological action of cocaine. In this monograph he wrote: “...the sensitivity completely disappeared in the injected limb of the frog. It is therefore the peripheral sensitivity, which is affected by cocaine acetate. Furthermore, the local action of this substance is very marked. Could one utilize it as a local anaesthetic?... the future must decide” [7]. Surprisingly, he did not continue with this crucial investigation.

Years later, in 1873, Hughes Bennett [8] confirmed the anaesthetic effect of cocaine on the tongue, but it was the Russian Vassili Von Anrep (1852–1925) who in 1880, after experimenting with its effects on his own body, recommended cocaine as a local anaesthetic [9]. For inexplicable reasons, he too, like his colleague Moreno y Maiz, did not pursue his research further.

Nonetheless at practically at the same time, Collin, Fauvel and Saglia observed that the local application of cocaine in the pharynx diminished its sensitivity, while Coupard and Bordereau in 1880 confirmed the loss of ocular reflexes after instilling the conjunctiva with cocaine solutions [10]. The path for the application of cocaine as a local anesthetic was therefore blazed. All that was needed then was to take the definitive step.

3. Carl Koller

Carl Koller's discovery is intimately associated with that of the noted psychoanalyst Sigmund Freud. During the first years of the decade that brought him to fame (1880s), Freud first began reading up on and then experimenting with cocaine. He described the characteristics of the plant, its uses for religious ceremonies and the circumstances by which coca leaves came to be recognized as a medicinal substance.

Though Freud mentioned the anaesthetising effect of cocaine when applied to the mucous membranes, and hence suggested its use as a local anesthetic, his main interest was focused on its mental and physical effects. He strongly recommended its application as a stimulant, the remedy against cachexia, cure for addiction to morphine/morphinism, alcoholism, and for asthmatic and digestive problems [11].

Carl Koller was born December 3, 1857 in Schuettenhofen (Bohemia). He studied jurisprudence for a year before taking up medicine in 1876 at the University of Vienna. As a medical student he made investigations in embriology in the laboratory of Salomon Stricker (1834–1894), professor of experimental physiology and pathology. In 1882 he qualified.

As a student of ophthalmology in the laboratory of Professor Ferdinand Arlt, Koller became acutely aware of the disappointing results of ocular surgery conducted under general anesthesia. The recovery was often accompanied by postoperative vomiting that triggered an increase in ocular pressure with subsequent damage to the eye which surgeons had tried to save in the first place. These were also the times when doctors had experimented unsuccessfully with bromide, chloral hydrate, morphine and cold.

Starting from the supposition that a substance paralysing the sensitive terminations of the mucous membrane of the tongue could not greatly differ in its action on the cornea and conjunctiva, Koller made a

number of unsuccessful experiments on animals with chloral hydrate, bromide, morphine and cold. In the summer of 1884, guided by the numbing effects of cocaine, Koller instilled a solution of muriate of cocaine into the eye of a frog to test its effect. Gaertner, another assistant in Stricker's laboratory and the sole witness of Koller's discovery, described years later the historic moment in the following words: "A few grains of the substance were thereupon dissolved in a small quantity of distilled water, a large, lively frog was selected from the aquarium and held immobile in a cloth, and now a drop of the solution was trickled into one of the protuding eyes. At intervals of a few seconds the reflex of the cornea was tested by touching the eye with a needle... After about a minute came the great historic moment, I do not hesitate to designate it as such. The frog permitted his cornea to be touched and even injured without a trace of reflex action or attempt to protect himself, whereas the other eye responded with the usual reflex action to the slightest touch. The same tests were performed on a rabbit and a dog with equally good results... Now it was necessary to go one step further and to repeat the experiment upon a human being. We trickled the solution under the upraised lids of each other's eyes. Then we put a mirror before us, took a pin in hand, and tried to touch the cornea with its head. Almost simultaneously, we could joyously assure ourselves: I cannot feel a thing. With that, the discovery of local anesthesia was completed" [12].

On September 11, 1884, Koller conducted with resounding success the first operation on cataracts with the newly discovered anesthetic (cocaine) on a stricken patient. Due to his low salary and that he was not allowed to leave his duties in the hospital, on September 15, 1884 his friend Josef Brettauer, also an ophthalmologist, presented his colleague's findings during the Ophthalmological Congress held in Heidelberg, Germany. On October 17th, Koller read his report before the Medical Society of Vienna [13].

The news concerning his achievement immediately spread across Europe and the United States. Cocaine became an overnight sensation and was used with success by doctors of other specialties such as Jellinek (laryngology); Bosworth (rhinology) Otis (urology); Fraenkel (gynecology) and Halsted (general surgery).

The ophthalmologists were the first to test Koller's novel technique. The first American contribution was made by Dr C Stedman Bull, an eye surgeon who introduced the topical application of cocaine in eye surgery on October 8, 1884. In the same year Hermann

Knapp upgraded the application of cocaine in the form of a hypodermic injection into the apex of the ocular orbit in order to anesthetise the eye globe [14].

In spite of the transcendence of his discovery, Koller's Jewish origin limited his opportunities for promotion at the university where there was still considerable anti-Semitism. He found this situation unbearable and, thoroughly disappointed, emigrated to New York City in 1888. During the following years, he continued his medical practice with considerable success. He became associated in the Mt. Sinai Hospital and the first Chairman of the Department of Ophthalmology at Montefiore Hospital in the Bronx.

In 1920 he was given an award from The University of Heidelberg. In 1922 he received a medal from The American Ophthalmological Society. Eight years later The New York Academy of Medicine honored him for his contributions to medicine and in 1934 he received another honorary citation from the American Academy of Ophthalmology and Otolaryngology.

The man who made this great contribution to ophthalmology and to medicine in general, died in New York in 1944 at the age of 87.

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