Historical Review

The history of neurosurgery in Bolivia and pediatric neurosurgery in Santa Cruz de la Sierra

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Received: 12 August 13   Accepted: 13 August 13  Published: 25 September 13

Abstract

The practice of neurosurgery in Bolivia began thousands of years ago with skull trepanation. This procedure dates from the earliest period of the Tiwanaku culture, a pre-Inca civilization. Neurosurgical development in Bolivia has its origins in the late 19th century and can be divided into two stages. At the beginning, before the advent of neurosurgery as a discipline, some general surgeons performed procedures on the skull and brain. Formal neurosurgery in Bolivia was developed with the arrival of neurosurgeons trained in the United States and some countries of South America. The Bolivian Neurosurgical Society was created in 1975. Nowadays, our national society has 74 members. It is affiliated with the World Federation of Neurosurgical Societies and the Latin American Federation of Neurosurgical Societies. Presently, neurosurgery in Bolivia is similar to that seen in developed countries. In this sense, government programs should dedicate more financial support to establish specialized healthcare centers where the management of complex central nervous system lesions could be offered. In contrast, we believe that encouraging the local training of young neurosurgeons is one of the most important factors in the development of neurosurgery in Bolivia or any other country.

Key Words: Bolivian neurosurgery, Bolivia, history, pre-Columbian culture

INTRODUCTION

Bolivia, founded in 1825, is situated in the center of South America and is bordered by Brazil and Paraguay to the north and east, by Argentina and Paraguay to the south and by Peru and Chile to the west. It is an inland country. Bolivia is a unitary nation, divided in nine departments, and its capital is Sucre. However, La Paz is the seat of the Bolivian government [Figure 1]. With a total land area of 1,100,000 km², it is the 27th largest country in the world. It is approximately three times larger than Germany, Italy, or Japan. Two-thirds of its territory corresponds to lowlands, and one-third is occupied by mountains and valleys. Spanish is the official language, but another 36 native dialects are spoken. According to the census of 2013, its population is 10,389,913 inhabitants.

Bolivia’s Human Development Index (HDI) for 2012 was 0.675 – in the medium human development category—positioning the country at 108 out of 187 nations and territories,[16] with a reported per capita income of $2,232. Life expectancy at birth is 67 years. Bolivia has an infant mortality rate of 40 per 1000 live births. Under-five mortality rate is 54 per 1000 live births. These indexes are among the highest in South America.
Neurosurgery in precolombian culture

**Skull trepanation**

The practice of neurosurgery in Bolivia began thousands of years ago with skull trepanation—the oldest neurosurgical procedures—which was learned in its western area. This technique dates from the earliest period of the culture and civilization of Tiwanaku, or Tiahuanaco, a preInca civilization located in Bolivia. Most archaeologists considered Tiwanaku as one of the key sites that led to the development of the Inca Empire. It was located in the highlands, approximately 3850 meters (12,600 feet) near Lake Titicaca bordering Peru [Figure 1]. This civilization began in approximately 1500 BC, becoming a center city, with a population estimated at 40,000 inhabitants, reaching its peak in 900 AD. Arthur Posnansky (1873-1946) argued that Tiwanaku was more than 15,000 years old and suggested that the Kalasasaya enclosure functioned as an astronomical observatory, a thesis that is now widely accepted [Figure 2].

To perform skull trepanations, instruments called *tumis*—the symbol of the Latin American Federation of Neurosurgical Societies—a ceremonial knife characterized by a semicircular blade, made of gold, silver, and bronze alloy, usually made of one piece—were used [Figure 3a]. It has been suggested that coca, which has local anesthetic properties and native to the Andes, could have been used to allay the pain of cutting through the scalp. It is probable that this procedure was performed for medical reasons, such as depressed fractures, because some were clearly surgeries after trauma. But other skulls showed no sign of previous injury, perhaps because the natives believed that bad spirits could cause discomfort, such as epilepsy and pain, and needed to be let out of the skull by trephining [Figure 3b and c]. Later, some devices were also found, such as suture needles, hemostatic forceps [Figure 3d], or brain spatulas, alike to those used by Olivecrona, or similar instruments to the dura mater elevator of Sauerbruch. Anthropologists have discovered evidence, which suggests that survival rates may have been as high as 60%.

According to Alvarado, Ephraim George Squier (1821-1888), an American archaeologist, and Adolph Bandelier (1840-1914), a Swiss-American, were the first ones to visit the ruins of Tiwanaku in the 1860s and 1880s, respectively. They described the skull trepanation performed by this civilization. Bandelier also verified a ceremony where this procedure was performed, on the shores of Lake Titicaca (La Paz). He collected 200 skulls, of which 65 (5%) had a trepanation, a percentage similar to that found by Céspedes and Villegas. [Intentional cranial deformation](#)

Artificial or intentional deformation was also applied in this territory. It is defined as the manipulation of the cranium through the application of an external appliance in order to alter the natural form of the skull. They applied small wooden boards or dressings with leather bands on the baby’s head during early childhood. The immediate consequence was an alteration in the normal closure of the cranial sutures. The cultural motivations for practicing this cranial deformation are numerous, but as most of the skulls found were those of women, it could have an aesthetic purpose or for the instillation of specific personality characteristics, protection against evil spirits, and identification of either individual (e.g., social status/rank) [Figure 4].

An overview of neurosurgery in Bolivia

After the late 19th century, the history of neurosurgery in Bolivia can be divided in two stages. At the beginning, neurological and mental diseases were taught in the universities, under the influence of the French school. The diagnosis was essentially clinical until some diagnostic methods arose at the end of this period, such as the first X-ray equipment in Bolivia that arrived in Sucre in 1896 [Figure 5]. At that time, only two more existed in

![Figure 1: Map of Bolivia and surrounding countries](image1)

![Figure 2: The Kalasasaya and the lower temples at Tiwanaku. The Ponce Monolith is shown aligned with the Kalasasaya main door. At equinoxes, the sun shines into the monolith](image2)
South America, one in Buenos Aires (Argentina) and the other in Santiago (Chile).[8]

Before the advent of neurosurgery as a discipline, some general surgeons performed procedures on the skull and brain. One of them was Felix Veintemillas Butrón (1889-1951) [Figure 6a]. He graduated from the University of San Andrés in 1913.[14] He was a professor of otolaryngology and bacteriology and carried out several neurosurgical procedures after 1920,[11] which he learned during his training in France, Switzerland, and Germany from 1914 to 1919.[1] He did numerous craniotomies for head trauma and brain tumors, demonstrating outstanding skills for their time.[17] For this reason, Veintemillas is recognized as the pioneer of neurosurgery in Bolivia.[1] Later on, during the war between Bolivia and Paraguay (1932-1935), Abelardo Ibáñez Benavente (1896-1977), a general surgeon and orthopedist trained in Chile, had the opportunity to perform peripheral nerve surgery on an individual wounded in this conflict. He wrote A New Suturing Technique and Vascular Grafts and, in 1936, with Vicente Gómez Carretero, a traumatologist, Reconstructive Surgery of the Peripheral Nerve Lesions.[17] Ibáñez was the founder of the Bolivian Surgical Society.[9]

Contemporary era of neurosurgery

Formal neurosurgery developed in Bolivia in the late 1940s with the arrival of neurosurgeons trained in the United States and some countries of South America. One of those neurosurgeons was Mario Michel Zamora [Figure 6b], who, after finishing his training in St. Louis, Missouri, with Prof. Roland M. Klemme, established his practice in La Paz in 1948. He was the first to perform a cerebral angiography and myelography iodine in 1949 to a patient with a dorsal meningioma. In 1957, he graduated as a medical doctor with the thesis “Surgical Treatment of Cerebral Hemorrhage.” He organized the first department of neurology and neurosurgery at the old La Paz General Hospital. In 1982, the Bolivian Neurosurgical Society (BNS) declared him as a pioneer and the founder of Bolivian neurosurgery.

Another pioneer of neurosurgery in Bolivia was Hugo Rodríguez Serrano (1925-1993), who practiced in Chile. After completing his training at the São Paulo Medical School of the Faculdade de Medicina da Universidade de São Paulo (FMUSP), Brazil, he did many procedures for head trauma and brain tumors, demonstrating outstanding skills for their time. Rodríguez Serrano was the founder of the Bolivian Neurosurgical Society (BNS).[9]

Figure 3: (a) Handheld tumi (AD 800-1100), (b and c) trephinations with bone regeneration, and (d) suturing needles and hemostatic clamps (photo courtesy of Dr. R. Alvarado-Reyes).

Figure 4: (a-c) Artificial cranial deformation with a left parietal healed trephination and an X-ray. A channel around the hole could be to place a plastia of gold or silver (photo courtesy of Dr. R. Alvarado-Reyes). (d) Reconstruction of pre-Hispanic faces of three men and one woman that lived in this region several centuries ago (M. Serrudo, Anthropological and Archaeological Museum of the University of San Francisco Xavier, Sucre, Bolivia. Available at: www.paginasiete.bo)
School in Brazil with Prof. Mattos Pimenta and at Johns Hopkins University in the United States with Prof. Earl Walker, he came to La Paz in 1953. He founded the Department of Neurology and Neurosurgery for the National Social Security Hospital in La Paz, beginning neurosurgery residency in 1972. Rodríguez Serrano established the first medical imaging computer center in Bolivia in 1983. In 1950, Dr. Nestor Enriquez, who also practiced in Santiago de Chile with Prof. Alfonso Asenjo, began to work in Sucre. He was the first professor of neurology and neurosurgery at the Universidad Mayor de San Francisco Xavier (founded in 1624) until his death in 1982.

Likewise, Oscar Quiroga Abasto [Figure 6c] (1924) was also a resident at the Neurosurgical Institute of Santiago (Chile), with postgraduate studies in Prague, Hamburg, and Marseille. He was the founding member of the Neurosurgical Societies of Chile and Bolivia and the Ibero-American Society for Neuroscience. In Cochabamba, where he practiced, he introduced microsurgery techniques in 1965, and he was the first professor of neurosurgery at the Universidad Mayor de San Simón between 1965 and 1984. Finally, in the mid 1960s, Dr. Carlos Arancibia and Dr. Oscar Román Vaca arrived to Santa Cruz from Chile and Argentina, respectively. In this city in 1967, the first angiography was performed at the San Juan de Dios Hospital.

The BNS and the Bolivian Society of Neurology were founded in 1975. The first president of the BNS was Dr. Oscar Quiroga Abasto. Nowadays, our national society has 74 members, one neurosurgeon for 140,405 people, slightly higher than the average in South America (1:123,000). Four of their members were Health and Welfare ministers (Oscar Román Vaca, 1978; Hugo Rodríguez Serrano, 1985; Joaquín Arce Lema, 1988-1989; and Carlos F. Dabdoub, 1992-1993). In this period, one of us sponsored and supported the 25th Latin American Neurosurgical Congress, which was hosted in La Paz. The BNS is affiliated with the World Federation of Neurosurgical Societies (WFNS) and the Latin American Federation of Neurosurgical Societies (FLANC). The society is organized into four chapters placed in La Paz, Cochabamba, Santa Cruz, and Sucre. The main centers of neurosurgery are in La Paz, Santa Cruz, and Cochabamba. The residency training is 5 years. After that, many new neurosurgeons undergo additional training for 6 months to 1 year, which is often undertaken in South America. BNS contributes to educational programs for the benefit of public as well as its members’ general health and biennially organizes its national congress in different cities of the country. The last 18th National Congress was held in Santa Cruz de la Sierra in October 2012, and the next one will take place in 2014 in the city of Cochabamba. In the same way, the XI Congress of the South Cone Society of Neurological Surgeons will be held in Santa Cruz in 2015.

Pediatric neurosurgery in santa cruz de la sierra
Santa Cruz (state) has a land area of 370,621 km² (33.74% of Bolivia). Its capital is Santa Cruz de la Sierra, and it is located in the heart of South America, at the east of the country [Figure 1]. It has an average altitude of 416 meters above sea level. It is the biggest and most populated city in Bolivia, and it is also considered the

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Figure 5: First X-ray equipment in Bolivia that arrived in Sucre in 1896

Figure 6: (a) Felix Yeintemillas, (b) Mario Michel Zamora, and (c) Oscar Quiroga Abasto
Surgical Neurology International 2013, 4:123
http://www.surgicalneurologyint.com/content/4/1/123

The situation in Bolivia is similar to other countries of Latin America. The main reasons include the following: (1) main efforts are directed to poverty reduction, primary health, infectious diseases such as parasitosis, and illiteracy. These factors contribute for a low standard of secondary and tertiary modern medicine, in which neurosurgery has a very small place; (2) the budget for health is inferior to the resources for the ministries of defense and government—in charge of the police. Therefore, wages for healthcare personnel are very low, so neurosurgeons must work in several institutions or combine their activities in private sanatoriums. The salary of a neurosurgeon with 10 years of experience in a public hospital hardly reaches $1500 per month. Many times, everyone must bring their own materials (craniotomes, neuroendoscopes, microsurgical instruments, etc.) to perform surgery in the public hospital where they work; (3) although information is received on a daily basis, new techniques cannot be applied because of poor technological support or the high cost of the imaging procedures that most patients cannot afford; (4) Pediatric neurosurgery is still seen as a branch of adult neurosurgery;[4] and (5) books and journals are limited. Their prices are elevated in relation to the country’s income, and most of the times, they are bought by neurosurgeons. The electronic mail is a good way.
of the main neurosurgical journals do not offer enough free articles for young surgeons.

We have an enormous technical gap with other developing countries because of the following: (1) there is not a good universal health system; (2) the prehospital system or paramedic system does not work properly because there is no good organization or not enough human resources or well-appointed ambulances; (3) there is an evident trend to centralize health care services to the larger cities; (4) there are not enough neurosurgical beds in hospitals and intensive care units; (5) there are neither proper surgical instruments nor modern diagnostic or therapeutic equipment, such as laser surgery, neuronavigation, ultrasonic aspirators, or gamma knife; and (6) in many cases, we still depend on national or international cooperation.

**Happy smile program: A good example**

A good example of international cooperation in pediatric neurosurgery is the Happy Smile Program, consisting of donations of shunts and medicines for children with hydrocephalus who come from low-income families. This program is possible because of the cooperation of the Spanish nongovernmental organization, ADASEC, and the government support of the Autonomous Community of Andalucia, in coordination with the Happy Child Foundation of Bolivia, which annually benefits approximately 70 indigent children. It provides regular checkups, educational workshops, physiotherapy, guidance, and support to parents in the recovery and rehabilitation of these patients. For 8 years, 502 children underwent this procedure, operated in the Japanese University Hospital and the Children’s Hospital of our city [Figure 8].

**CONCLUSIONS**

Until now, some challenges have been overcome; however, many others must be solved. As in other developing countries, the progress to modern neurosurgical practices in Bolivia is largely due to foreign assistance, especially from South America and the United States. In this aspect, Bolivia is visited by some charitable missions each year.

As in other countries in Latin America, government programs should dedicate more financial support to establish specialized healthcare centers in strategic areas away from large urban concentrations where the management of complex CNS lesions could be offered.[13]

In contrast, we believe that encouraging the local training of young neurosurgeons is one of the most important factors in the development of neurosurgery in Bolivia or any other country.

Besides the creation of a universal set of instruments at a low price for neurosurgeons in developing countries and the establishment of renowned training centers for young neurosurgeons, such as Rabat in Morocco or Recife in Brazil, the WFNS has poor information about some database on instruments or equipment disposed by rich countries that may be offered to neurosurgical centers in third world nations. Likewise, among its “purpose, aims, and objectives,” the WFNS foundation is: (1) “supporting neurosurgeons in developing areas of the world”; (2) “receiving and accepting donations, gifts, grants, or contributions in kind and cash from any (nondelinquent) person (s), associations, societies, companies, authorities, or governments, for the furtherance of the aims and objectives of the foundation”; (3) “providing funds for purchasing the necessary equipment, the donation of equipment, or the selling of equipment at a very low price to those in need of it”; and (4) “teaching neurosurgery and research in neurological sciences worldwide, with emphasis on the needs of developing countries.”[21] These objectives must be engaged by all the members of the WFNS; remember that “the mission of the WFNS is to work together with our member societies to improve worldwide neurosurgical care, training and research to benefit our patients.”[21]

Finally, different organizations (WFNS, FLANC, WHO, PAHO, etc.) should analyze the difficulty to purchase books or medical journals. Its promotion must be more aggressive, finding other ways to obtain cheaper books and to provide more free articles in the neurosurgical journals of the world. Surgical Neurology International is a good example of this issue.

**ACKNOWLEDGMENTS**

The authors thank Ramiro Alvarado, MD, for his assistance in preparing this manuscript.

**REFERENCES**

1. Alvarado-Reyes R. Contribution to the history of neurology and neurosurgery in Bolivia. First Bolivian Congress of history of medicine, 1987, 5-9.
2. Alvarado-Reyes R. Trepanation pre-Columbian. Files Bolivian Hist Med 1997;3:79-84.
3. Bandelier AF. Aboriginal Trephining in Bolivia. Am Anthropol 1904;6:440-6.
4. Basauri LT. The present and future state of pediatric neurosurgery in Latin America. Childs Nerv Syst 1999;15:800-1.
5. Bakhsh A. CSF shunt complications in infants – an experience from Pakistan. Pediatr Neurosurg 2011;47:93-8.
6. Campos M. History of epilepsy surgery in Latin America. 1st ed. In: Méndez J, editor. Historia de la Federación Latinoamericana de Neurocirugía (FLANC); 2002. p. 370.
7. Céspedes GG, Villegas VH. Pathology in Pre-columbian Skulls. Bolivian Inst Cult 1976, p. 22-6.
8. Dabdoub Arrien C. The Hospital. Past, Present and Future. Santa Cruz (Bolivia): 2004, p. 90.
9. Gómez González J, Briceño-Iragorry L, Rabi Chara M. Biographical Medical Dictionary Hispanic-American. Caracas (Venezuela): 2006;2:91-2.
10. El Khamlichi A. Neurosurgery in Africa. Clin Neurosurg 2004;26:134-7.
11. Endara-Guzmán J. Neurosurgery History in Bolivia [in Spanish]. 1st ed. Jorge Méndez, editor. Historia de la Federación Latinoamericana de Neurocirugía (FLANC), 2002. p. 98-108.
12. Gerszten PC, Gerszten E. Intentional cranial deformation: A disappearing form of self-mutilation. Neurosurgery 1995;37:374-82.
13. Guinto-Balanzar G. Neurosurgery in Latin America. World Neurosurg 2010;74:41-2.
14. Hartmann LF. Félix Veintemillas. Files Bolivian Hist Med 2000; 6: 119-21.
15. Loza-Balsa G. Encyclopedia of Aymara Medicine. La Paz (Bolivia): OPS-OMS editor, 1995, p. 132.
16. Human Development Report. Bolivia (Plurinational State of). Available from: http://www.undp.org/. [Last accessed on 2013 June 04].
17. Luna-Orosco J. History of Surgery in La Paz. First half of the twentieth century [in Spanish]. Files Bolivian Hist Med 1995;1:59-71.
18. Pérez SI. Artificial cranial deformation in South America: A geometric morphometric approximation. J Archaeol Sci 2007;34:1649-58.
19. Posnansky A. ‘Tiahuanaco, the Cradle of American Man’. Ministry of Education: La Paz (Bolivia) editor, 1957;2:90-1.
20. Ríos Dalenz J. History of Medical Residency in Bolivia. Files Bolivian Hist Med 1995;1:185-9.
21. World Federation of Neurosurgical Societies (WFNS). Available from:http://www.wfns.org/. [Last accessed on 2013 June 04].