



Original Research

Lower Body Negative Pressure: Historical Perspective, Research Findings, and Clinical Applications

George J. Crystal, PhD^{*}, M. Ramez Salem, MD

Department of Anesthesiology, Advocate Illinois Masonic Medical Center, Chicago, IL

A B S T R A C T

Lower body negative pressure (LBNP) is a technique that redistributes blood from the upper body to the dependent regions of the pelvis and legs, thus reducing central venous pressure and venous return. The subject is placed in a cylindrical air-tight metal tank, which is sealed at the level of the iliac crests, and subatmospheric pressure is produced using a vacuum pump. This article reviews the historical background, physiological effects, research findings, and clinical applications of LBNP. LBNP is found in both the basic science and clinical literature, encompassing its diverse investigational and clinical applications. The first references to LBNP were in 1952 describing its effectiveness in inducing hypotensive anesthesia. Major interest in LBNP began in the mid 1960s when it was used to characterize the cardiovascular responses to hemorrhage and orthostatic stress, especially that associated with the weightlessness of space flight; these studies have continued to the present day. Advantages of LBNP for such experimental studies include the following: (1) The degree of central hypovolemia is easily controlled and has a rapid onset and reversal. (2) The technique is repeatable, reproducible, and noninvasive. (3) No exogenous pharmacologic agent is required to produce venous pooling. (4) The findings are independent of gravity. In recent years, a few institutions have applied LBNP clinically to diagnose abnormalities in cardiovascular autonomic function and, when combined with echocardiography, to uncover changes in cardiac performance through analysis of Starling curves.

© 2015 Anesthesia History Association. Published by Elsevier Inc. All rights reserved.

Lower body negative pressure (LBNP) is a technique that redistributes blood from the upper body to the dependent regions of the pelvis and legs, thus reducing central venous pressure and venous return. The technique involves the placement of a subject in a cylindrical air-tight metal tank, which is sealed at the level of the iliac crests, and the production of subatmospheric pressure by a vacuum pump (Fig. 1).^{1,2} We reviewed the literature for the historical background, physiological effects, research findings, and clinical applications of LBNP.

The precursors of LBNP include the ancient practice of bloodletting and cupping, a derivative method that permits a reversible withdrawal of blood from the circulation. Bloodletting originated in ancient times, as a treatment for disease.^{3,4} The practice was based on an ancient system of medicine in which blood and other bodily fluid were considered to be “humors” whose proper balance maintained health. Sick patients were thought to have an imbalance of their humors, which bloodletting could correct. Bloodletting originated in the ancient civilizations of Egypt and Greece and lasted for 2500 years. It was not until late in the 19th century that scientists such as Louis Pasteur (1822–1895; chemist, microbiologist, France), Joseph Lister (1827–1912; surgeon, Scotland), and Robert Koch (1843–

1910; physician, Germany) demonstrated that germs, not humors, were responsible for disease. This led to bloodletting losing favor and becoming extinct.

Cupping is accomplished by applying cups to the skin in which a partial vacuum is created by means of heat or suction. Cupping became part of Western medicine at the time of Hippocrates (ca. 400 BCE). The French physician Victor-Théodore Junod (1809–1881) adapted cupping to the entire limb, which allowed a redistribution of large volumes of blood away from the systemic circulation.^{5–7} In 1833, Junod presented to the Academy of Sciences his device, which became known as “Junod’s boot” (Fig. 2). He claimed that the device could produce beneficial effects, such as a reduction in fever and inflammation and that it could induce syncope, allowing surgical procedures to be performed painlessly. Junod’s boot was widely advertised to the public (Fig. 3). It was popular in French hospitals and was also tried in British hospitals, albeit with mixed results.

In the last decade of the 19th century, August Bier (1861–1949; Germany), a surgeon and professor at the University of Bonn, proposed a sophisticated theory of hyperemia, meaning “excess of blood,” as a treatment for disease. He provided the following rationale for his theory: “Lesions are always accompanied in nature by hyperemia, the most widespread of all auto-curative agents. If we wish to imitate the processes of nature, we need to increase the blood-current and

^{*} Corresponding author.E-mail address: gcrystal@uic.edu (G.J. Crystal).

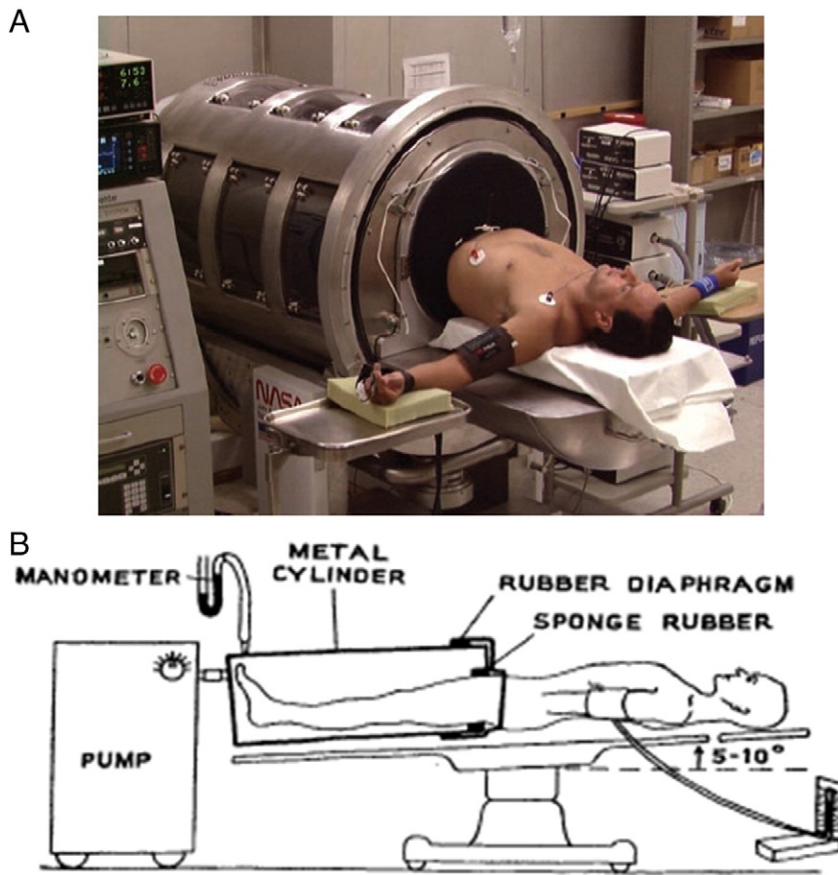


Fig. 1. A. Subject placed in the LBNP device. From Cooke et al.¹ B. Diagram of early negative pressure device showing application of a cylinder to legs of patient. From Saunders.²

create an artificial hyperemia.”⁸ Bier recommended several means of increasing the blood supply to a diseased body part, including hot air baths, dry cupping, and suction devices, based on the principle of Junod’s boot (Fig. 4). He claimed that hyperemia had analgesic, bactericidal, nutritive, absorptive, and regenerative capabilities and recommended its application in the treatment of tuberculosis and other diseases. Bier later gained recognition, which has lasted to the present day, for his accomplishments in anesthesia.^{9,10} In 1898, while at the Royal Surgical Hospital of the University of Kiel, Germany, he was the

first physician to perform spinal anesthesia for a surgical procedure using “cocainization” of the spinal cord as an alternative to general anesthesia.¹¹ Bier is also recognized for providing in 1908 the first description of intravenous regional anesthesia, a technique that has become known as a “Bier’s block.”¹² The therapeutic applications of negative pressure promoted by Junod and Bier were initially met with moderate enthusiasm but shortly thereafter lost proponents. Although cupping gradually disappeared in America in the early 20th century, it led to LBNP, which emerged 50 years later.

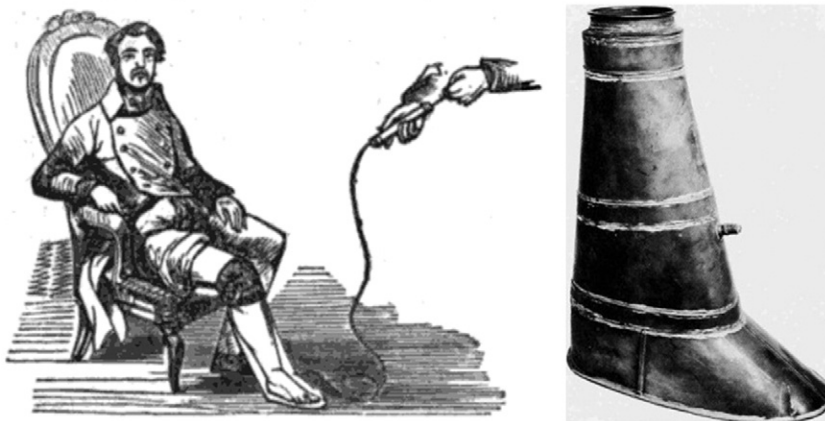


Fig. 2. Junod’s boot was constructed of metal and secured against the limb by a silk stocking. The top of the boot was kept in air-tight apposition to the leg by means of a broad rubber belt. To the boot was attached a flexible tube, stopcock, pump, and a manometer for measuring the vacuum produced.

Download English Version:

<https://daneshyari.com/en/article/1082287>

Download Persian Version:

<https://daneshyari.com/article/1082287>

[Daneshyari.com](https://daneshyari.com)