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International innovations in pediatric minimally invasive surgery: the Argentine experience

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Abstract This is a presentation about innovations in pediatric minimally invasive surgery and a review of the Argentine experience. The most representative are (1) the thoracoscopic treatment of long gap esophageal atresia with novel techniques; (2) the nonsurgical and minimally invasive treatment of chest wall deformities, particularly of pectus carinatum; and (3) the use of magnetic surgical devices in classic laparoscopy and transumbilical surgery.

It has been an unexpected privilege to receive an invitation to be a lecturer at the Canadian Association of Pediatric Surgeon's Annual Meeting. Together with other Argentine colleagues for the last 15 years, we have been developing new concepts and ideas in a variety of topics in our specialty. During this lecture, I will show some of the ideas that ultimately became innovative procedures.

Argentina is the southern country in South America. The political framework is a federal representative democratic republic divided into 23 provinces and 1 autonomous city. It is a beautiful country blessed with natural resources such as the Iguazú falls in the northeast, the rich plains of the Pampas in the northern half, the Patagonia glaciers in the south, the rugged Andes along the western border, and the Moon Valley in the northwest. According to the preliminary results of the 2010 census, Argentina's population is approximately 40 million with a population density of 15 persons/km^2, a value well below the world average of 50 persons/km^2. The 10 largest metropolitan areas account for half of the population, and fewer than 1 in 10 lives in rural areas. In fact, about 3 million people live in Buenos Aires City, and the Greater Buenos Aires metropolitan area totals 13 million inhabitants, making it one of the largest urban areas in the world. The official language is Spanish. Argentina is the second economy in South America with a gross domestic product of almost as high as that of the state of Ontario, but with an unequal distribution of wealth and income. In synthesis, Argentina is a country of contrasts.

Its health system is no different. Health care is provided through a combination of employer and labor union–sponsored plans and government and private health insurance plans, as well as through public hospitals and clinics. Most of the people go to public hospitals, though, and around 38% of them receive free medical care. Most patients with highly complex cases are referred to Buenos Aires City, where there are 3 main public children's hospitals and a

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private children's hospital. I trained at Ricardo Gutierrez Children's Hospital and practiced, for 16 years, as a staff surgeon in the Garrahan National Children's Hospital. The latter is a 500-bed publicly supported institution that receives referrals from all over the country. It is an extremely busy hospital but always underresourced. In 1993, we performed the first pediatric minimally invasive surgery (MIS) there. Since then, about 3000 MISs have been performed in pediatric patients and more than 400 in neonates. Currently, residents perform 83% of all MIS cases.

Frequently, unions keep on striking and preventing the staff access to the institution and to work efficiently. In addition, there is scarce governmental, institutional, or industrial financial support for innovation. Indeed, there is no formal research budget, no travel expenses, or no scheduled time off for research or study. The resources for all these matters personally funded for the most part. Hence, with this day-to-day reality, is it possible to innovate and succeed? Is there room for creativity in such an adverse environment? In his recent Journal of Pediatric Surgery Lecture at the 2008 American Pediatric Surgical Association (APSA) meeting, Dr Thomas Krummel wisely said that "… scarcity and necessity drive innovation" and "no department, school or university exists in a vacuum; the surrounding environment inevitably colors the attitudes and either dampens or accelerates the process." [1,2].

During that same meeting, in a brilliant conference about creativity and the surgeon, Dr Michael Gauderer stated that "the availability of a 'sounding board,' colleagues, or other supportive individuals with whom new ideas can be openly discussed is an invaluable asset. Tenacity and perseverance are essential." [3].

Therefore, what approach is needed to be creative and innovative and at the same time succeed in any environment, especially in adverse ones? To answer this question, I would like to cite the following passage from the Bible's book of Proverbs: "Go to the ant, thou sluggard; consider her ways, and be wise!" [4]. What King Salomon expressed is that human beings need to study the ants for they are the most successful living creatures on earth. They can survive in extremely adverse environments. Although their size is 1 millionth the size of a human being and each one weighs between 1 and 5 mg, taken collectively, they rival people in the scale of their world domination. Their biomass equals the biomass of the entire human population. In effect, the Earth may be considered as a huge ant nest! [5]. Moreover, their approach is focused, fearless, persistent, and self-motivated. They are an organized team with effective communication (chemical signals, pheromones), and most importantly, they use "The Three Musketeers approach": "Tous pour un, un pour tous" ("All for one, one for all"). Based on their example, I will show you the teamwork of different "ants" who have been working in different "ant nests" in Argentina.

In effect, our first achievement was the first textbook on neonatal surgery in Spanish, which consists of 79 chapters (900 pages) written by 89 collaborators. More than 3000 issues have already been distributed in South America [6]. Likewise, the most representative innovations in MIS were (1) the thoracoscopic treatment of long gap esophageal atresia (LGEA) with novel techniques; (2) the nonsurgical and minimally invasive treatment of chest wall deformities, particularly of pectus carinatum; and (3) the use of magnetic surgical devices in classic laparoscopy and transumbilical surgery (TUS).

1. Long gap esophageal atresia

The definition of LGEA is controversial [7]. We define it as any esophageal atresia (EA) in which the distance between the pouches prevents a primary anastomosis [8]. These cases constitute 10% to 20% of all patients with EA. They are unique and very challenging. The surgeon's main objective is to preserve the patient's native esophagus in every case. Because this is not always possible, patients may undergo esophageal replacement with the colon, stomach, or jejunum. Laparoscopic gastric replacement is our first choice [9].

Before describing techniques, we have to consider the patient's previous condition. To establish treatment strategies, it is crucial to consider whether the patient has a type A or any other kind of EA, whether the patient has an esophagostomy, and whether the long gap is caused by a short proximal pouch, a short distal pouch, or both (Fig. 1A). The following are some of the technical resources we have been using to avoid esophageal replacement: delayed primary anastomosis (DPA), intrathoracic elongation (IE), and extrathoracic elongation (EE) (Fig. 1B).

1.1. Delayed primary anastomosis

This is the technical resource we use in patients with type A LGEA (no fistula). Whenever the distance between pouches is less than 1 vertebral length, we perform an esophageal anastomosis. If the gap is larger than 1 vertebra, we take monthly measurements for a period of 3 months until the distance between pouches reduces to less than 1 vertebra. In this case, a DPA is performed. We believe that the optimal approach for LGEA repair is the thoracoscopic approach [10-12]. The patient is placed in a three-quarters left prone decubitus position. Two 3-mm trocars and one 5-mm trocar are used. A bougie is introduced through the gastrostomy under fluoroscopic control, so the surgeon can have access to it. A more flexible bougie is introduced through the mouth (Fig. 2). Although the surgeon pushes the lower bougie cephalad, the anesthesiologist pushes the upper bougie caudally. A primary anastomosis is performed when you observe that both pouches overlap a little bit. For these patients, we prefer to use a *Roeder knot* because it is very quick and neat. The Roeder knot is a sliding knot that enables the