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Overcoming Obstacles: The legacy of Fidel Pagés, founder of the epidural, 100 years after his passing

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Abstract

Fidel Pagés, a Spanish surgeon, tragically died in 1923 at the age of 37, just two years after his publication “Anestesia Metamérica”, the first description of human thoracolumbar epidural anesthesia. In the intervening 100 years, epidural anesthesia has faced countless obstacles, starting with the dissemination of his initial report which was not widely read nor appreciated at the time. However, the merits of the technique have fueled innovations to meet these challenges over the years. Even today, while epidural anesthesia is widely embraced, particularly in obstetric and chronic pain medicine, the pressures of the operating room for efficiency and a low tolerance for failure, pose modern day challenges. Here we revisit Pagés’ original report and highlight the key innovations that have allowed for the evolution of this essential anesthesia technique.

Keywords

Epidural; Fidel Pagés; Anesthesia History; segmental anesthesia; ultrasound guidance

Introduction

Fidel Pagés pioneered accessing the epidural space to deliver segmental anesthesia over 100 years ago and paved the way for the modern era of neuraxial techniques. This year marks the centennial anniversary of his untimely death. His early passing was the first among many challenges that threatened the adoption and success of epidural anesthesia. However, the excellent quality of anesthesia first observed by Pagés has driven advances that have brought epidural anesthesia to its routine use in clinical anesthesia today.

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Early Career and Pursuit of Segmental Anesthesia

Fidel Pagés was born in 1886 in Huesca, Spain to a wealthy family.[1] He graduated from University of Zaragoza with his medical degree in 1901 and subsequently joined the Spanish army. As a military surgeon he worked in many of Spain's armed conflicts including those in North Africa, and in World War 1.[1] In times of peace, he worked in several different cities before attaining a permanent position as *Cirujano de la Beneficencia* (Charity Surgeon) at the General Hospital of Madrid. He advanced academically and became the Editor in Chief of the journal *Resita de Sanidad Military* as well as the founder of the journal *Revista Espanola de Cirugia*.[2] It was here that he published many articles including his most famous publication that described thoracolumbar epidural anesthesia.

Two years prior to his death, in 1921, Pagés (Photographed Figure 1A) published his seminal work, "Anestesia Metamérica", in which he described the anatomy and boundaries of the epidural space. This article details his technique for accessing the epidural space, documents his surgical case series, highlights his complications, and argues the benefits of the method. This remarkable manuscript was the first description of thoracolumbar epidural anesthesia in human patients.[3] The term *Anestesia Metamérica*, was coined by Pagés to describe the unique segmental anesthesia that is intrinsic to the technique. Just two years after its publication, he was killed in a car crash on returning from a family vacation. He was only 37 years old.

Like all innovators, Pagés was indebted to the pioneers of neuraxial anesthesia who came before him. The American neurologist James Corning likely administered the first epidural anesthetic in 1885, although he mistakenly thought his injection affected the spinal cord through local blood flow.[4] Thirteen years later August Bier successfully demonstrated the first spinal anesthetic and reported it the following year in 1899.[5] Inspired by this newfound anesthetic technique, others naturally experimented with neuraxial injections, both subarachnoid and peridural. Pagés himself acknowledged the work of the French physicians Fernand Cathelin[6] and Jean-Athanse Sicard[7] who in 1901 independently developed the caudal injection as a method for accessing the sacral epidural space. The caudal technique, while effective for lower extremity anesthesia and labor analgesia, was limited by the anatomic variability in patients' sacral bones, leading to an inability to traverse the sacral hiatus in a significant proportion of cases.[8]

In the 1920s spinal anesthesia was widespread and reliable with a procaine spinal offering up to 60 minutes of operating time.[9] Spinal anesthesia does not allow for segmental anesthesia which led Pagés to experiment with delivery of local anesthetic to the epidural space "to desensitize the nerves that are distributed through the operating field." In Pagés' manuscript (and illustration Figure 1B) he detailed his initial idea and the first thoracolumbar anesthetic:

> (…) while I was carrying out spinal anesthesia, I had the idea of detaining the cannula within the spinal canal, before it pierced the dura mater, and then blocking the roots outside the meningeal space before the needle traversed the corresponding foramina, since the point of the needle had traversed the corresponding yellow ligament. (…)

> Testing for sensitivity we determined that within five minutes, in the infra-umbilical portion of the abdomen, hypesthesia commenced which extended to the anterolateral aspects of the lower extremities, leaving intact the perineum, scrotum, posterior aspects of the lower extremities and the soles of the feet bilaterally, hypesthesia became accentuated progressively, and within twenty minutes after the injections we decided that it was permissible to begin to operate. We carried out radical repair of a right inguinal hernia without the least discomfort to the patient.[3]

The successful anesthetic led to further development of Pagés' two techniques for accessing the epidural space. The first was the simplest as it involved accessing the subarachnoid space, confirming with free cerebral spinal fluid (CSF) flow, then withdrawing the needle until CSF flow ceased. Aspiration without additional CSF confirmed that the needle was withdrawn from the dura. Ease of injection would imply that the tip was in the epidural space while high resistance implied that the needle was positioned within the ligament.[3]

The second technique for accessing the epidural space was depicted by Pagés as "definitely more sophisticated and not any more difficult than the first, after a certain amount of practice."[3] He described the different sounds that are produced as the needle traverses the ligamentum flavum and then the dura mater, which could be combined with the sensation of resistance from the needle to judge the position of the needle tip. His choice of equipment was a spinal needle "with a very short bevel that is not very sharp, of medium caliber" ("0.8mm,"the present-day equivalent of 18G).[3]

In addition, Pagés offered dosing suggestions and summarized common physiologic effects of epidural blockade. He reported increased pulse and respiratory rates. Hypotension was not observed, unless "all the spinal nerves were anesthetized." (Blood pressure, while not routinely monitored intraoperatively at the time, was specifically measured with a Pachon's Sphygmomanometer in Pagés' report. Interestingly, this device allowed accurate measurement of the diastolic blood pressure by use of an aneroid oscillometer but was succeeded by the simpler Korotkoff method.[10])

From Obscurity to Ubiquity: success through innovation

Despite the remarkable accounts in this article, Pagés and the future of epidural anesthesia faced many significant challenges, the first of which was receiving credit for primacy. Achille Dogliotti, an Italian surgeon who developed and described the loss-of-resistance technique in 1930s,[9,11,12] initially did not give credit to Pagés. The intentionality of his omission is not known. It is possible that he was unaware of Pagés' work because of Pagés' untimely death and the limited circulation of the Spanish journals that published his work. Others have suggested that low esteem held for Spanish physicians by their German and French counterparts at the time or Dogliotti's personal ambition may have perpetuated Pagés' relative anonymity.[1] Had it not been for essays by the Argentinian surgeon Alberto Gutiérrez, pioneer of hanging drop technique in 1933,[13] who gave the credit to Pagés as the founder of the field, Pagés' work might have been forgotten. Eventually, Dogliotti did recognize Pagés in 1939 by way of Gutiérrez.[12]

Another practical challenge to epidural anesthesia was the temporal limitations of a single injection, prompting innovations with continuous administration. Continuous caudal anesthesia was pioneered for obstetric anesthesia by Robert Hingson in 1941[14] as others worked to improve continuous spinal anesthesia. William Lemmon developed a reproducible technique using special operating tables to accommodate sub-arachnoid malleable needles.[15] However, these advances had their own limitations with caudal and spinal techniques resulting in inconsistent blocks and postdural-puncture headaches, respectively. The Cuban anesthesiologist Miguel Curbelo pioneered the use of ureteral catheters for continuous lumbar epidural anesthesia as a solution to both issues. His technique gained popularity after a demonstration at the Mayo Clinic in Minnesota,[16] culminating in his landmark *Anesthesia and Analgesia* publication in 1949.[17] Technical refinements and the evolution of equipment[18] ensured the adoption of continuous epidural anesthesia in surgery and obstetrics. Simple innovations such as depth markings on the catheter and the Tuohy needle[19,20] were critical for accurate placement.

Along with the widespread adoption of this technique came complications that were not always described in detail in the initial reports. John Bonica and Philip Bromage were important figures in the field not only for their scientific study of the epidural, but also for their emphasis on patient safety. They recognized the myriad of potential complications with neuraxial anesthesia such as infection, neurologic sequelae, and mortality, and warned of their frequency.[8,21,22] Despite challenges with various complications such as adhesive arachnoiditis with spinal chloroprocaine[23] and cauda equina syndrome related to continuous spinal anesthesia,[24] neuraxial anesthesia has prevailed as techniques have evolved, driven by the same quality of anesthesia that Pagés initially observed.

Risks and Benefits: contemporary challenges and solutions

The benefits of epidural analgesia are numerous but primarily are related to excellent perioperative analgesia.[25–29] Other studies have shown a decrease in complications such as acute renal and respiratory failure, cardiac arrythmias, and a decrease in postoperative mechanical ventilation time.[30] In thoracic and major abdominal surgery, epidurals have been shown to decrease mortality and pulmonary complications.[31,32] Reduction in opioid consumption is another benefit, as well as a decrease in the incidence of paralytic ileus.[29]

One hundred years after Pagés' death, epidural analgesia is intimately tied to pain medicine and obstetric anesthesia. In the United States 71.3% of deliveries are carried out with neuraxial analgesia.[33] Interventional pain medicine specialists similarly perform epidural injections as a regular or intermittent therapy with increasing frequency.[34] However, despite all the advantages, a new set of challenges are arising in the operating room that may limit epidural use for surgery in the future.

Like the challenges that have forced the evolution of neuraxial anesthesia for the past 100 years, our present-day health care system is a new obstacle that is influencing the future of the epidural. The pressure to perform timely turnovers between cases conflicts with this occasionally time-consuming technique, especially as providers lose technical proficiency. Postoperative epidural management necessitates dedicated acute pain teams or providers

who can follow their patients longitudinally. This is not universally possible, particularly in systems with limited resources. A push for shortened hospital stays, a trend toward out-patient surgery, the use of post-operative protocols and ERAS pathways all present additional challenges to epidural management. Urinary retention, which may be increased after neuraxial anesthesia, also presents a barrier to recovery.[35] Practical concerns with deep vein thrombosis (DVT) prophylaxis and anticoagulation complicate the time course of placement and removal of catheters. Finally, regional anesthesia techniques, such as the paravertebral and erector spinae blocks, have become fashionable, because of claims of similar segmental anesthesia to epidural anesthesia, ease of placement under ultrasound visualization, and decreased risk of hematologic complications.[36] Perhaps most frustrating of all, is epidural failure which is devastating for a patient's pain control and presents an imbalance in the risk-benefit ratio.

For epidural analgesia to have a continued role, these challenges must be addressed. One technique in its infancy which has the potential to address these issues is the use of real-time ultrasound guidance. Although many technical challenges exist for visualizing the epidural space with ultrasound including deep structures that underly echogenic structures such as the spine, off-line views of the spine which can aid in needle placement and depth have existed for years (Spine Sonogram Figure 2).[37–40] Advances in point-of-care ultrasound and new techniques have prompted the development of hand-held devices specifically for neuraxial anesthesia.[41]

Recently, Kim et al. reported a case series of 38 patients undergoing epidural placement with real time needle guidance, with final loss-of-resistance confirmation without ultrasound.[42] Similarly, Pakpirom et al. demonstrated increased first pass success with this hybrid technique compared to conventional approach.[43] However, while they reported fewer skin punctures and attempts, the procedure time was longer using ultrasound. Where this technique may hold promise is for increasing precision of placement, directing needle trajectory, and avoiding inadvertent dural puncture which could lead to higher success rates, increased patient satisfaction and time saved from replacing failed catheters. Like the influence that real-time ultrasound has had on peripheral nerve blocks, it is possible that with continued use, ultrasound guidance for epidural placement will decrease procedure time and complications.[44] However, questions remain as to the safety and efficacy of even basic questions, like acoustic coupling with gel (which can be toxic[45]) versus safe solutions such as dextrose.[46]

Conclusion

The history of the epidural is one of constant evolution with innovators rising to meet challenges of the day. In fact, despite Pagés' tragic death 100 years ago, the technique has been disseminated, improved upon, and has become an integral part of the modern anesthesiologist's armamentarium. While the present day demands of the modern anesthesia practice challenge the use epidural anesthesia, the superior pain relief and segmental anesthesia that Fidel Pagés observed and described will continue to drive its evolution for the next 100 years.

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Glossary of Terms

CSF	Cerebral Spinal Fluid
DVT	Deep Vein Thrombosis
G	gauge

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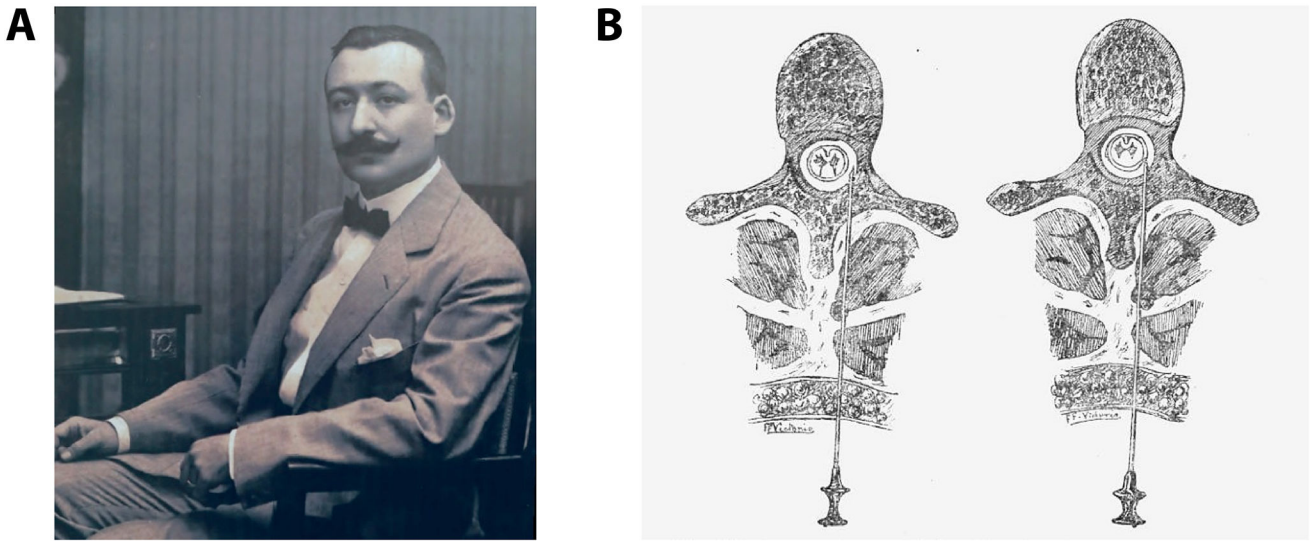

Figure 1.

A. Undated photograph of Fidel Miravé Pagés (1886–1923). His publication Anestesia Metamérica in 1921 remains one of the most important descriptions of modern anesthesia for its primacy in demonstrating the efficacy of thoracolumbar epidural anesthesia. **B.** Original drawings depicting accessing the epidural space from Fidel Pagés shows his superb understanding of anatomy and the consistency of the technique.

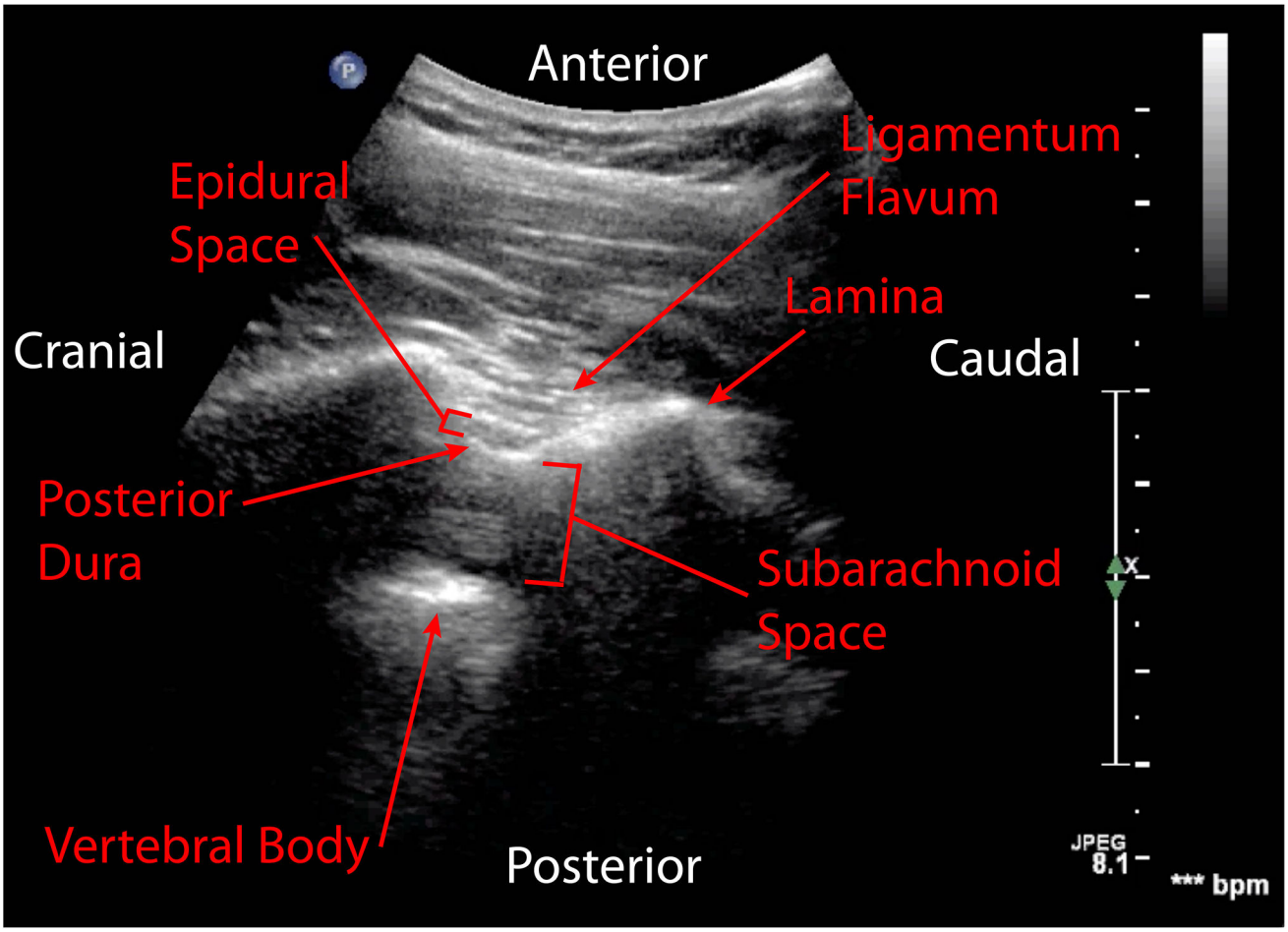

Figure 2. Parasagittal oblique (PSO) view of the lumbar 3–4 interspace.

The lamina, ligamentum flavum, posterior epidural space, subarachnoid space, cauda equina and vertebral body are all evident. The lamina have a classic “sawtooth” appearance with caudal inclination. The ligamentum flavum has a band-like appearance with fibrillar echotexture. The posterior epidural space consists of hypoechoic fat with sparse connective tissue (semifluid composition). The posterior epidural space has a trapezoidal shape in the PSO view and is slightly wider towards the cephalad edge of the interspace. The subarachnoid space is nearly devoid of echoes (does not contain natural scatterers). The cauda equina consists of fine linear echoes within the subarachnoid space that are parallel and exhibit cardiac pulsations (not shown). The vertebral body is highly echogenic.