Isadore Max Tarlov (1905–1977) and the controversial Tarlov cyst: historical perspective

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Isadore Max Tarlov, an early neurosurgeon, made several important contributions to the field of spine surgery. He described sacral perineural cysts, now known as Tarlov cysts. Dr. Tarlov also introduced the knee-chest patient position to facilitate exposure and hemostasis in lumbar surgery. In addition, he developed the use of fibrin glue in nerve repair. His book on mechanisms of spinal compression was published in 1957. He published a book of essays titled *Principles of Parsimony in Medical Practice* that remains highly relevant in today's medical world.

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THE incidence of Tarlov cysts is estimated at approximately 5%, but symptomatic cases constitute less than 1%.¹³ Tarlov cysts are most commonly diagnosed by lumbosacral MRI and can often be shown by CT myelography. Asymptomatic Tarlov cysts do not require treatment. Most perineural cysts are asymptomatic. Dr. Isadore Max Tarlov was the first person who described the spinal perineural cyst. This article is an attempt to reflect upon Dr. Tarlov's life and work.

Biography

Isadore Max Tarlov (Fig. 1) was born on May 16, 1905, in Norwalk, Connecticut, and spent his childhood there. He graduated from Norwalk High School in 1922. He went to Clark University in Worcester, Massachusetts, where he was elected to Phi Beta Kappa and graduated in 1926. As a student of Robert Goddard, pioneer of astronautics and one of the inventors of the rocket, Tarlov became interested in a scientific career. He obtained his medical degree from the Johns Hopkins Medical School in 1930, and then finished his training as a first resident under Wilder Penfield in neurosurgery at the Montreal Neurological Institute. Tarlov also had fellowships in neurosurgery at the University of Chicago with Percival Bailey and at Barnes Hospital in St Louis with Dr. Bernard Sachs. He married Fella Bechman in 1938. He studied the anatomy and pa-

thology of the spinal nerves of the subarachnoid space and described the cysts of the sacral roots. In 1938, Dr. Tarlov described the cyst for the first time in his paper.¹⁹ Later, he published several articles on spinal cysts. During World War II, he introduced a method of gluing injured nerves together using blood plasma. In his 1969 text, *The Principle of Parsimony in Medicine*, he presented his insightful approach to the practice of medicine based on Oslerian concepts. Isadore Tarlov died in June 1977 at 72 years old in Brooklyn, New York. Dr. Tarlov's greatest legacy to his patients was his compassion and respect for them.⁴ In 2006, a foundation was formed by a father of a young patient with a Tarlov cyst and a nurse/medical educator who was also a patient with a Tarlov cyst. The goal of the foundation is to promote knowledge of the Tarlov cyst. This foundation also provides a platform for all patients with Tarlov cysts to share their experiences.

Description of the Tarlov Cyst by Dr. Tarlov

In 1938, during dissection of 30 cadavers at the Montreal Neurological Institute, Dr. Tarlov described the presence of cysts in the posterior portion of the sacral root at the junction of the spinal ganglion in 5 patients. His description of sacral nerve root cysts contributed to acceptance of the study of the spine as a worthy endeavor. In his publication, he described the evolution of the perineural

FIG. 1. Photograph of Dr. Isadore M. Tarlov. Image courtesy of Centro Integral de Ozonoterapia Medica, Jalisco, Mexico.

cyst with its etiopathogenesis. He also showed the pathological basis of the cyst origin with serial histological sections (Fig. 2 [I]). He demonstrated the location of the cyst and its relationship to nerve roots (Fig. 2 [II]). Dr. Tarlov's comprehensive study on perineural sacral cysts introduced a new type of spinal cyst.¹⁹

Other Contributions

Introduction of Fibrin Glue in Nerve Repair

Although Bergel et al.³ introduced fibrin glue as a hemostatic agent in the early 20th century, Dr. Tarlov later popularized the use of fibrin glue in nerve repair. The technique was described in an animal study. The first step in this technique was dissection and cutting the sciatic nerves of rabbits, followed by keeping the cut end of the nerves as close as possible and depressing the end to form the trough. The next step was the addition of 5 drops of autologous plasma and 1 drop of autologous muscle tissue extract. The fluids were allowed to mix in situ, and to keep a lesser amount of the clot as suture material, about 3 drops were withdrawn into a pipette. Clot formation took 40 seconds but nerve ends were kept close for 4 minutes to make sure that the clotting process was complete. Separation of the nerve stumps was performed after confirming the strong tension on the suture line or poor tensile strength of the clot. Thirty percent of the operations were successful.²¹

Introduction of the “Dry Surgical Field” in Spine Surgery

Dr. Tarlov, in collaboration with William Cone in Montreal, demonstrated a unique “knee-chest position” in spine surgery (Fig. 3). This position was promising for

FIG. 2. I: Photographs showing the relationship of the cyst to nerve roots. A cyst (c) is shown at the lower sacral nerve roots (A) and on the posterior sacral nerve root (B). Reproduced with permission from Tarlov: *Arch Neurol Psych* 40:1067–1074, 1938. II: Photographs showing the pathological basis of the cyst origin. A: Origin in the perineural space (s) between the endoneurium (e) and the perineurium (p). The epineurium (f) surrounds the perineurium. Large, thin-walled blood vessels (b) are located just under the endoneurium. B: Image showing an increase in the size of the cyst. C: Bifurcation of a bundle of nerve fibers, with the beginning of the formation of 2 cysts. Note the prominence of blood vessels adjacent to the cysts. D: Double cyst of a nerve root. Note the round cell infiltrations (r and r') in the epineurium. Infiltration may involve the perineurium. E: An increase in the size of a cyst (c) is shown. A bundle of nerve fibers is compressed at 1 side. There is early cyst formation (y) on an adjacent root. Reproduced with permission from Tarlov: *Arch Neurol Psych* 40:1067–1074, 1938.

FIG. 3. Intraoperative photograph of the knee-chest position.

lower lumbar surgery. The advantage of this position is less compression on the chest and abdomen, leading to less pressure in epidural veins. The venous pressure can be further reduced if the head end of the table is kept low. This innovative positioning is still in use in spine surgery today.⁴

Experimental Study on Mechanism of Spinal Cord Injury

It was in 1954 that a pioneering animal study on dogs by Tarlov first established the benefit of early decompression in improving neurological outcome after spinal cord compression.²⁵ He demonstrated the various types of histopathological findings of spinal cord injury in relationship to the time frame of decompression. His experimental work on spinal cord injury was well received in the world neurosurgery forum regarding the timing of spinal decompression.

Publications

Dr. Tarlov was a pioneer of spine surgery and research related to the spine. He had numerous publications about spinal disorders and surgeries, including "Acute spinal cord compression paralysis."¹⁵ The early decompression of the spinal cord was advised by Dr. Tarlov for both incomplete and complete sensory motor paralysis. For incomplete compression, conservative treatment could be the first option, but if progressive neurological deterioration was noted then prompt laminectomy was indicated. In complete paralysis, if laminectomy was performed in a short interval then the outcome was promising. He also published several books on spinal cysts and nerve repair techniques, including *Plasma Clot Suture of Peripheral Nerves and Nerve Roots; Rationale and Technique*²¹ and *Sacral Nerve-Root Cysts; Another Cause of the Sciatic or Cauda Equina Syndrome*;²³ both publications were important contributions by Dr. Tarlov. In addition, he authored 57 published journal articles on various neurosurgical disorders, including experimental studies on spinal cord injury, peripheral nerve injuries such as brachial

FIG. 4. Photograph of Dr. Tarlov's featured book, published in 1959. Image courtesy of the Burton Report Spine Hall of Fame Biographies.

plexus injury, and experimental neurography.²⁴ In another notable publication, *The Principle of Parsimony in Medicine*²² (Fig. 4), he expressed his insightful approach to the practice of medicine. He also conveyed his philosophical view in his article "The physician as teacher, student, and practitioner."²⁰

Modern Concept and Treatment Options for Tarlov Cysts

The etiology of "Tarlov cyst," a unique cyst of the nerve root sleeve, is unknown. Tarlov^{15,17,25} proposed that ischemic degeneration, inflammation, or hemorrhage, either infiltrating from the subarachnoid space or of traumatic origin, could lead to cyst formation. Other authors have suggested that Tarlov cysts form as a result of arachnoidal proliferation¹² or an obstruction of perineural lymphatic tissue.⁶

Tarlov cysts are usually asymptomatic. Dr. Tarlov¹⁸ postulated that these cysts could cause sacral radiculopathy. Surgical intervention for Tarlov cysts is usually ill advised. Various nonoperative therapies include lumbar CSF drainage^{2,5} or CT-guided cyst aspiration,^{10,11} but neither of those treatments prevents symptomatic cyst recurrence. Neurosurgical techniques for symptomatic perineural cysts include simple decompressive laminectomy,¹⁴ cyst and/or nerve root excision,^{9,26} and microsurgical cyst fenestration and imbrication.⁸ Acosta Jr. et al.¹ reported a case

of a symptomatic cyst managed with cyst fenestration, cyst wall resection, and closure with myocutaneous flap reinforcement to prevent cyst recurrence or CSF leakage. Lucantoni et al.⁷ reviewed the various management options of a cyst and their outcome. Numerous complications can follow surgical intervention, including perineal sensory loss, incontinence, CSF leak, and worsening pain.

Conclusions

This article acknowledges the legacy of Dr. Isadore Max Tarlov and his seminal work on the spinal cord. It also brings insight into Dr. Tarlov's innovative works on the spinal cord and motivates future neurosurgeons to take the initiative to develop their own innovations in neurosurgery.

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Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Konar. Acquisition of data: Konar. Analysis and interpretation of data: Konar. Drafting the article: Konar. Critically revising the article: Konar, Bir, Maiti, Bollam. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Nanda.

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