

# How Mohs Surgery Transformed Into a First-Line Treatment of Skin Cancer

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## Abstract

Mohs surgery is considered ideal treatment for many types of skin cancers. Developed by Dr Frederic Edward Mohs (1910–2002), Mohs surgery allows all surgical margins to be viewed microscopically, ensuring no cancer cells go unremoved, yet it failed to achieve immediate acceptance when first introduced in the 1940s. A catalyst to the widespread acceptance of Mohs surgery occurred with the work of dermatologic colleagues who reported excellent results without using the paste. It suggested the real innovation of Mohs surgery lay in its microscopic control and not the paste, the discontinuation of which removed all the problems associated with its use.

## Keywords

surgery, pathology, cancer

The transition from novel discovery to established medical dogma is not always smooth. This was the case for Mohs surgery, which was developed by the surgeon Dr Frederic Edward Mohs (1910–2002) in the early 1930s while in medical school.<sup>1</sup> While the procedure that bears his name was not always viewed with such high regard, Mohs surgery is currently considered the optimal treatment for many types of skin cancers as it is tissue sparing and results in high skin cancer cure rates. The real innovation of this surgery lies in sequential tumour removal with horizontal sectioning and precise histologic mapping until there is no microscopic evidence of the tumour.

While working as a cancer research assistant for Professor Michael Guyer at the University of Wisconsin, Mohs collaborated on the effect on colloidal platinum injections on rat cancers.<sup>1</sup> He became interested in leukocyte infiltration of cancerous and normal tissues and tested out a number of irritants, including a 20% zinc chloride solution.<sup>1</sup> He noted that tissue necrosis resulted, but the killed tissue also retained its normal architecture. The zinc chloride produced in situ fixation similar to what occurs when tissue is removed and placed in formaldehyde. In an effort to accurately fix, remove, and orient excised tissue, Mohs experimented with tissue fixation and patented a paste vehicle that would hold the zinc chloride solution, yet release it to the tissues to produce controllable tissue fixation. In 1936, he started treating patients with skin cancers in the dermatology clinic, removing cancerous tissue layer by layer and sectioning the entire undersurface of each successive layer until there was no evidence of cancer. The paste was applied overnight, and the next day, a saucer-shaped piece of tissue was removed in a relatively bloodless field.<sup>2</sup> This novel approach of tissue

removal allowed for 100% of surgical margins to be viewed microscopically and resulted in high cure rates of recurrent skin cancers.<sup>3</sup> Mohs refined the technique with edge colour coding of the excised tissue to precisely locate the tumour and maintain the orientation of the excised tissue so he could return to a specific area to remove only tissue where cancer cells were found microscopically.<sup>4</sup> This conserved tissue and improved cosmesis.<sup>5</sup>

One month before publishing his series of 440 cancers in 1941, Mohs presented his new surgical technique at the Western Surgical Association's meeting in Topeka, Kansas, but it was not well received.<sup>1</sup> The next day, the *Wisconsin State Journal* praised Mohs's work in a front-page news story,<sup>6</sup> but many in the medical community were unsure. Surgeons branded it as “black magic” due to the dark colour of the paste.<sup>7</sup> It was lumped in with other “cancer cure” pills, potions, and ointments that abounded during the first of half of the 20th century. During the 1920s, American Harry M. Hoxsey, an ex-coal miner with a grade 8 education, started to promote himself as a healer. Amongst his remedies was an escharotic dark red salve that was almost identical in composition to Mohs paste.<sup>8</sup> This similarity and the horror stories associated with the use of the dark red salve in Hoxsey's

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clinics resulted in concern about Mohs paste by the medical community.<sup>9</sup> The use of these salve products, which are poorly regulated and lack quality control, can result in severe skin damage, and there are no scientific studies for clinical efficacy or safety.<sup>10</sup>

Surgeons at the time believed cutting into tumours would cause the tumours to spread, so Mohs's approach of removing the tumour piece by piece was thought to be dangerous.<sup>9</sup> Surgeons also rejected the procedure since as opposed to the standard procedure of closing the wounds immediately,<sup>5</sup> wound reconstruction after use of the paste had to be delayed until the remaining fixed tissue had sloughed off. Although Mohs's surgical colleagues were less than supportive of his technique, dermatologists embraced it. Mohs was invited to give his first lecture to dermatologists at the annual meeting of the American Academy of Dermatology in 1946 in Cleveland.<sup>1</sup> Then in 1947, the *Archives of Dermatology* published his article on the use of Mohs surgery for removal of facial tumours.<sup>9</sup> When Mohs founded the American College of Mohs Surgery (formerly the American College of Chemosurgery) in 1967, most of the 23 original members were dermatologists.<sup>9</sup> Indeed, very few of the early trainees were surgeons, but the number of dermatologists who came to train with Mohs numbered in the hundreds.<sup>1</sup> In Canada, there are 26 dermatologists currently registered as Mohs surgeons with the Canadian Dermatology Association. The majority are in Ontario and Quebec (with 8 Mohs surgeons each), and the remainder are working in Alberta (6 Mohs surgeons), British Columbia (3 Mohs surgeons), and New Brunswick (1 Mohs surgeon).

Today, Mohs surgery is not considered unusual practice but rather standard practice. However, its eventual acceptance was a long process. Although cure rates were very high, the zinc chloride paste had some drawbacks. Firstly, it was uncomfortable; secondly, only 1 stage could be completed in 1 day; and thirdly, reconstruction had to be delayed until all the fixed tissue had sloughed off.<sup>2</sup> Mohs first performed his technique under local anaesthesia without the use of the paste in 1953 while trying to quickly finish making a film demonstrating the technique. He found that tissue removal under local anaesthesia was faster and resulted in less eye irritation. In 1969, he presented a case series of 70 eyelid cancers removed with this "fresh-tissue technique"; after a 5-year follow-up, all were cured.<sup>2</sup> The dermatologists Dr Theodore Tromovitch (one of the first physicians to train with Mohs) and Dr Samuel Stegman were instrumental in securing the widespread acceptance of Mohs surgery. In the 1970s, they reported great success performing Mohs surgery

under local anaesthesia.<sup>1</sup> According to Tromovitch, his patients' outcomes were equally successful, with reportedly less morbidity.<sup>9</sup> The eventual disuse of the paste helped to eliminate the association between Mohs surgery with charlatans applying caustics to tumours, and it became much easier for others to appreciate the value of Mohs's methodology, a transition that would not have occurred without the help of dermatologic colleagues.

Mohs's legacy was made through his contributions to the rise of surgery in the field of dermatology. The technique's real innovation was sequential removal, horizontal sectioning, and precise microscopic control, rather than the zinc chloride paste that had caused so much resistance from surgical colleagues. Mohs surgery performed by the fresh-tissue technique continues to ensure very high cure rates with maximal tissue preservation for patients today.

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