

Evolution of the Hoffmann Fixators

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KEY WORDS

History
External fixation
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ABSTRACT

Dr. Raoul Hoffmann of Geneva, Switzerland with the collaboration of Henri Jaquet developed the original Hoffmann external fixateur as a system for treating broken bones without necessarily opening a fracture site to reposition the bone ends. This system has evolved to a more flexible, modular concept with input from surgeons and engineers. In this chapter the modifications of the Hoffmann family of fixators are traced and the important steps in the development of the concept and the instrumentation emphasized.

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Hoffmann original

In his youth, Raoul Hoffmann worked with his brother as an apprentice carpenter in the Place de Bourg-de-Four in the old section of Geneva. Hoffmann had qualifications in theology and medicine from the University of Geneva and was a line officer (not a medical officer) in the Swiss Alpine patrol where, being a Swiss citizen, he reported periodically for obligatory duty. When he set up practice in general surgery in the Village of Tramelan in the Jura, Hoffmann doubtless treated ski fractures of the tibia.

By the 1930s external skeletal fixation was an established, if special, technique. Fixators were linear constructs. The fracture site was opened, the bone repositioned, a fixator applied and the skin closed. Skin wounds, particularly wounds over subcutaneous bones, can be problematic. Raoul Hoffmann, who moved back to Geneva with his private surgical practice because the government built a road through his house, became interested in solving the problem of fracture reposition without opening the fracture site. Hoffmann was a gentleman, a tennis player and also a religious thinker. He had a famous ironic smile.

Hoffmann was concerned about the problems of infection at the bone-pin junction. Parkhill and Lambotte had surface treated their pins to prevent skin reactions. Hoffmann conducted research in rabbits. Finally he found a manufacturer in Biel who could make a tempered stainless steel pin that was sharp enough to penetrate bone without causing too much heat [1]. The story is told that on the night before his presentation of his fixator to the Surgical Society, he obtained a bone from the pathology department, made a fracture and mounted a fixator on the bone

to show at the meeting. By morning all that was left was the external fixator as his dog had finished off the bone.

The thrust of Hoffmann's report to the Swiss Surgical Society in 1938 was the invention of a fixator for controlled reduction of fractures with a closed (in contrast to an open) technique. Raoul Hoffmann applied for a Swiss Patent on 6 April 1938. The Patent for his «Fixateur pour le traitement des fractures des os» was awarded on 15 March 1939. This was a difficult time that coincided with the rise of National Socialism in Germany. Switzerland remained neutral with a closely controlled border with Germany. Hoffmann broke his leg in an accident and apparently continued to bicycle to work in an external fixator until the tibia healed [2]. Custom devices were manufactured for Hoffmann (Figure 1, the Hoffmann 'key'). Ullrich in nearby Ulm, Germany, refused to make the clamps because he thought that the market for them would be too small [1,3]. In 1947 a shop was set up in Geneva by the new engineering graduates Henri and Georges Jaquet for the manufacture of medical devices that required 'mechanics and/or electronics.' In 1948 Jaquet Frères began to make Hoffmann Fixators with an improved design using two plates and a wing nut to give more secure fixation of the pin holding the clamp to the connecting rod. The original components were fabricated in stainless steel with a grooved Bakelite surface to hold the pins (Figure 2). The pins were manufactured in tempered stainless steel. Parts were made one-at-a-time on machine-lathes and finished and controlled by hand. The basic components were ball-joints, rods, a hand brace for inserting the pins, guides and a skin lance [1]. Hoffmann's essential innovation was the bone handle, in French *rotule*. The concept was to create a solid anchorage in bone by placing two or three pins along the axis of the bone and fixing these pins in a pin-holding clamp. One grip was proximal and one was distal to the fracture to enable manipulation of the bone for fracture

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Fig. 1. The 'key' from Hoffmann's early fixator – much like the key to a church gate. Courtesy Dr. Anne-Christine Hoffmann and Dr. Richard Stern, University Hospital, Geneva, Switzerland.

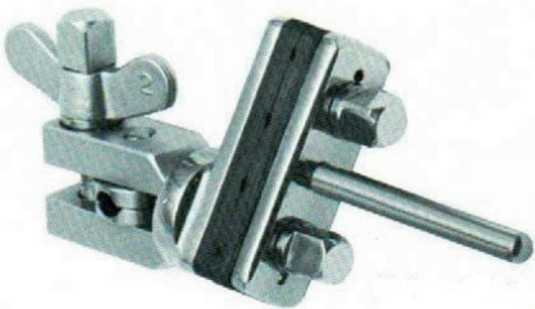


Fig. 2. The Ball Joint Rod in stainless steel with Bakelite pin holders was the workhorse of the original Hoffmann.

reduction. In Hoffmann's original system the position of the bone was localised with a pin guide. The position of the guide was facilitated by fine pins that centre the guide on the bone. In addition to the concept of percutaneous bone anchorage, Hoffmann added the requirement that the device allowed for adjustment of bone position after surgery [4,5]. Hoffmann conceived a temporary external fixation for war surgery by connecting pin groups with plaster of Paris [6]. The Hoffmann Fixator was used in the district (Canton) Hospital in Frauenfeld, which is in Thurgau near Zurich where Hoffmann assisted Dr. Isler. When the Chief of Surgery at Frauenfeld changed in 1965, the AO-Tubular System was substituted, and all the Hoffmann equipment was returned to a disappointed Raoul Hoffmann, who by this time was 84 years old [3]. Hoffmann's fixator was used by Prof. Jacques Vidal in Montpellier for the treatment of difficult fracture problems. Vidal emphasised that the rigid frames promoted fracture healing by providing good stability [7]. The quadrilateral frame developed by Vidal and his student Jose Adrey (Figure 3) was widely demonstrated at International Symposia sponsored by the Hoffmann manufacturers [8]. As the business grew, the plant was managed by Georges Eduard A. Deutsch, a precise, small man with a noticeable limp who chain-smoked strong cigarettes with a cigarette holder. His engineer, Marcel Wagenknecht, was a bachelor who lived with his mother and grew roses.

Hoffmann II - Plan-les-Ouates

By 1972, to respond to increased demand in the United States, Jaquet Frères opened a new plant near la Paraille in Geneva. Jaquet

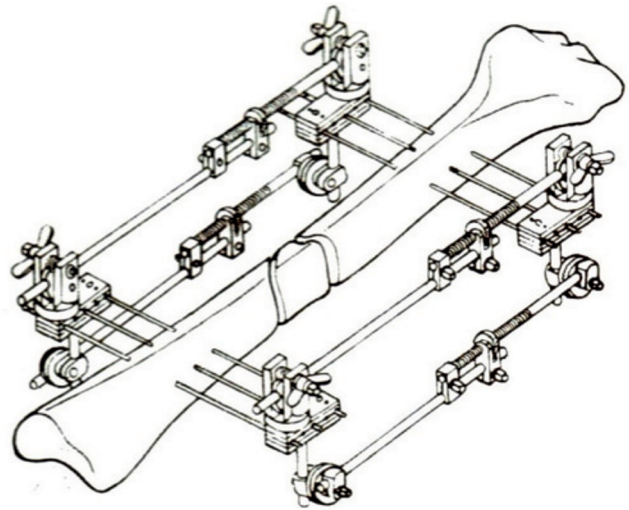


Fig. 3. The Vidal-Adrey frame provided great rigidity at a fracture site. Courtesy Mitchell Orthopedics Supply, Louisville, Kentucky.

Orthopédie was acquired by Howmedica, a division of Pfizer, in 1980. This improved the marketing of original Hoffmann frames in the US. In 1982 a new plant was opened in Plan-les-Ouates, an industrial zone in Geneva. By 1995 only 2% of Hoffmann fixators were sold in Switzerland, the sales were divided with 46% in Europe, 33% in the US, 17% in the Far East and 4% in Canada and South America.

The Vidal-Adrey approach delegated external fixation to the solution of complex, slow-healing and infected fractures with rigid often cumbersome frames. As early as 1988, there was a reaction to this approach by both Asche in Freudenstadt and Burney in Illkirch, who suggested the evolution of simpler components that could be used more flexibly and in closed fractures. In 1989, Asche, Court-Brown, Poka and Seligson met in Rochester, New York to review Asche's experience in 29 patients with new, more modular components for external fixation [9]. Priorities included reducing the number of clamps and providing a more versatile multi-pin clamp, and emphasising the use of a rod-coupling as a pin holder. In the original Hoffmann, pin inserts for 3 and 4 mm half pins could be placed in the articulation coupling to turn it into a pin-holding clamp. However, the coupling had to be slid onto the connecting rod prior to clamping the rod in the frame. In the Hoffmann II (Figure 4), the pin-to-bar clamp could be snapped onto a bar even though the bar was fully locked in a frame. This feature became the 'clique fantastique.'

The Hoffmann II project was managed by John Kalblein of Howmedica. The physician advisory group included Andy Burgess, Franz Burny, Ekki O. Karaharju and Gregory Zych in addition to Asche, Court-Brown, Poka and Seligson. Loren Latta participated since the mechanical testing was conducted in his laboratory in Miami. The group met over the years in places like Glen Eagles in Scotland, Paris, Grenada, Garmisch-Partenkirchen and Geneva. The leading engineer for the original Hoffmann, Marcel Wagenknecht retired and was replaced by the energetic and thorough Jacques Mata.

Each winter, Gernot Asche led a fracture symposium in Freudenstadt. As new parts became available they were incorporated in the workshops of the Freudenstätter Courses. The Hoffmann II manufactured in the Howmedica Factory in Plan-les-Ouates was brought out as a complete system in 1995.

The external fixation field by this time included large pin distractors for bone lengthening, such as the Wagner Device, small wire frames based on traction bows, like the Ilizarov fixators, and mobile joint-spanning frames, for example, the Volkov-

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