

A 'forgotten' pioneer of orthopaedic and trauma surgery: Prof Dr Hans Brun (1874–1946)

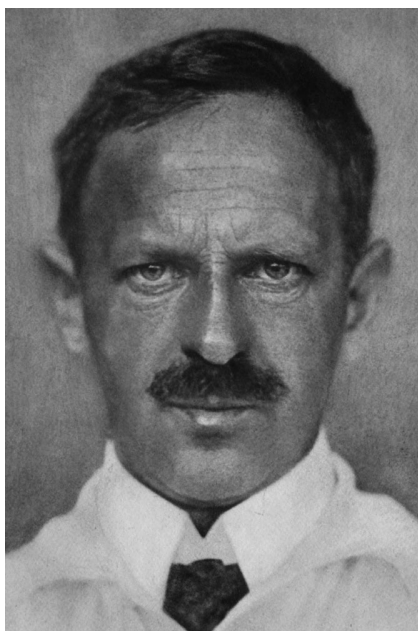


Fig. 1 Hans Brun (1874-1946).

The evolution of surgical fracture treatment encompassed a complex, decades-long process built on clinical and scientific experience, to which many surgeons as pioneers contributed important and decisive clinical as well as experimental findings [2, 37]. The early days of surgical fracture treatment experienced frequent complications, such as disrupted fracture healing, deformation and dysfunction. The scientific study of the biological and biomechanical issues facing bone healing and the testing of new biomechanical concepts in fracture care led to a lasting change in the surgical treatment of broken bones in the following decades [2, 35, 41]. Between 1930 and 1955, many of the scientific findings and surgery-related developments gained from clinical experience, and were later integrated into the concept and systematics of functionally stable fracture treatment [2, 41].

The Swiss surgeon Prof Dr Hans Brun (1874-1946) should also be mentioned as one of the pioneers in this field, for his clinical-scientific activity in the period between 1920 and 1940 contributed to the surgical treatment of fractures [14, 21, 38, 40] (fig. 1).

His methods for the osteoplastic treatment of malunion fractures and pseudarthroses, developed between 1920 and 1940, albeit being advanced, only received scant attention at his time [38, 40]. Later pioneers of the surgical fracture treatment adopted selected operating techniques from Brun, which were further developed and incorporated into the concept of modern fracture treatment [40, 46].

Recognising this 'forgotten pioneer' of the surgical fracture treatment may also be regarded as an expression of the fact that passionate and sustained clinical-scientific activity at the opportune time will receive the appropriate acknowledgement.

Professional Career

Hans Brun was considered a highly talented, self-critical surgeon with an excellent scientific performance record. He completed his surgical training with *Ulrich Krönlein* (1847-1910) at the university hospital in Zurich, and in 1913, he earned his habilitation with his successor *Ferdinand Sauerbruch* (1875-1951). *Sauerbruch* had an appreciation for Hans Brun's comprehensive training, his broad clinical-surgical experience and the extraordinary scientific interest he displayed [40] (fig. 2).

As a senior military surgeon during the First Balkan War (1912-1913) and the First World War (1914-1918), *Hans Brun* was confronted with the enormous scale of complex issues facing the treatment of fractures resulting from devastating injuries obtained by gunshots, fragments, and explosions.

Following mediation by *Ferdinand Sauerbruch*, Brun led a surgeon's mission for the Swiss Red Cross between February and May of 1913 – in the first Turkish-Bulgarian Balkan War (1912-1913) – at the *military field hospital of the 2nd Bulgarian army* in Dimotika (Western Thrace) near Adrianople [1,36, 40]. Within this period, he reorganised the deleterious structure of the ambulance service at the Bulgarian field hospital, and, with his team of seven surgeons, treated a total of 2,341 war injuries, which covered the



Fig. 2 Ferdinand Sauerbruch (1875-1951) around 1915. Director of the university hospital for surgery in Zurich (1910-1918).

entire war-surgical spectrum at the time (1, 36, 40) (fig. 3).

With the outbreak of the First World War, the mediation by the Chief Medical Officer of the Swiss Armed Forces led to Brun taking over the management of the *Deutsches Festungslazarett 28* [German field hospital] in Strasbourg [24, 40] as chief surgeon in 1914/1915. He thus joins the ranks of great Swiss surgeons that were active abroad during the First World War performing war surgery, such as *Hermann Matti*, *Friedrich Steinmann*, *Fritz Zollinger*, *Friedrich de Quervain*, *Cèsar Roux*, *Carl Schlatter*, *Hans Hoessly*, *Charles Julliard* and *Eugen Bircher* [24].

Here, he particularly addressed the issue of the risk of infection posed by perforating gunshot wounds with cavitation defects as well as large soft tissue and bone defects [24]. He published the experiences he gained from the treatment of 1,330 secondary infections of extremity injuries in his monograph 'On wound treatment and immobilisation in the midst of warfare' in 1915 [6, 38].

In 1916, the Swiss government gave its approval for the internment,



Fig. 3 Left: Hans Brun (2nd from the right) and his team in the Bulgarian field hospital in Dimotika (February 1913); right: Hans Brun in the operating theatre of the main field hospital.

hospitalisation and treatment of severely wounded military personnel (70,000) from the Central Powers and the Entente [21, 23, 24] (**fig. 4**). Upon that, Hans Brun assumed the management of the *Eidgenössische Armeesaniitätsanstalt* (A.S.A.) [military hospital], including the integrated *Deutsche Interniertenspital* [hospital for German internees] in Lucerne [21]. The A.S.A.'s *surgical clinic* had an intake capacity of two hundred severely wounded patients and five surgical units [24].

In light of the experience Brun had gained from war surgery, the treatment focused on

orthopaedic and reconstructive surgery for trauma to complex extremities, such as joint, but also craniofacial injury [21, 24].

Often, the assigned war-wounded had already undergone several operations and presented with complications, such as poorly healed and infected fractures, with or without bone loss; aseptic and infected pseudarthroses; or disabling deformities and extremity defects [21, 24, 27] (**fig. 5**). Between 1916 and 1919, Brun and his team of seven surgeons performed a total of approx. 2,500 surgical and orthopaedic procedures [21,23,24] (**fig. 6**).

In 1916, Brun and *Charles-Émile Cornioley* – a drafted surgeon who later on became a professor in Geneva – were the first surgeons in Switzerland to introduce continuous, antiseptic irrigation drainage [16,39] for the localised treatment of infected fractures and pseudarthroses with regular monitoring of the microbiology at the A.S.A. military hospital [17, 24] (**fig. 7**). A treatment method that had been pioneered by *Alexis Carrel* (1873-1944) at the French military hospital 21 in Rouen between 1914 and 1916.



Fig. 4 The A.S.A. and the 'Deutsche Interniertenspital' in Lucerne (1917). Hans Brun and his surgical team A.S.A. (1916).

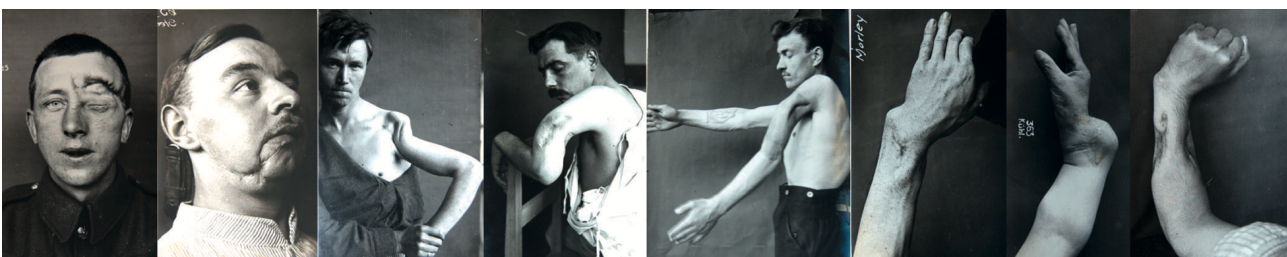


Fig. 5 Bone and soft tissue defects, pseudarthroses as well as deformities in military internees A.S.A. (1917).



Fig. 6 German infirmary — treatment of fractures (nail extension according to Steinmann, Ledergerber, and Zollinger) at the A.S.A. (1917).

To improve rehabilitation, Brun established an *orthopaedic and neurological rehabilitation ward* within the surgical clinic. His effort received support from the distinguished neurologists *Otto Veraguth* (1870-1944), *Mieczyslaw Minkowski* (1884-1972) and the orthopaedist *Hans Hoessly* (1883-1918) — all of whom would later become professors in Zurich [7, 21, 27, 48]. This type of interdisciplinary cooperation was unprecedented at the time [21]. Simultaneously, Brun created the hospital's own *prosthetics workshop*, which was led by an orthopaedist. Military internees from different nations with training in orthopaedic technology manufactured orthopaedic appliances and artificial limbs at the workshop [24] (**fig. 8**).

In 1917, *His Imperial Highness General Prince Alfons of Bavaria* and *Marschall Philipp Petain* paid a visit to the A.S.A. and Hans Brun in recognition of their merits towards the German war-wounded and the French 'Grandes blessés dans la guerre' [24] (**fig. 9**).

After the dissolution of the '*Deutsche Interniertenspital*' in 1922, Hans Brun took over the management of the surgical clinic '*Im Bergli*' in Lucerne, where he mainly performed orthopaedic surgical procedures until 1944 [24, 40].

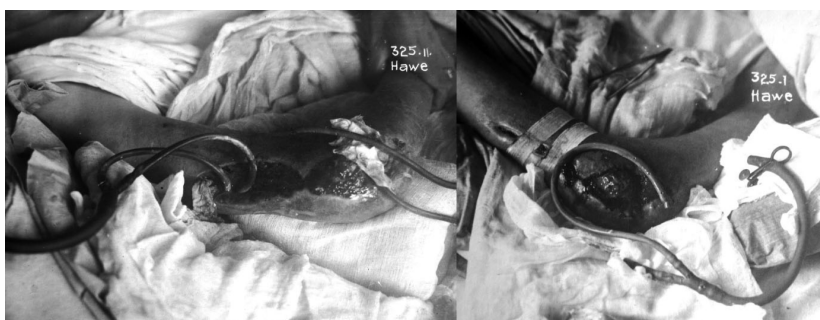


Fig. 7 Irrigation drainage for infected gunshot-induced fracture in the lower leg, according to A. Carrel (A.S.A. 1917).



Fig. 8 Prosthetics workshop A.S.A. (1917). A Swiss doctor fits a prosthetic leg for an amputated French soldier. In the background, a Prussian soldier is working as an orthopaedic technician.

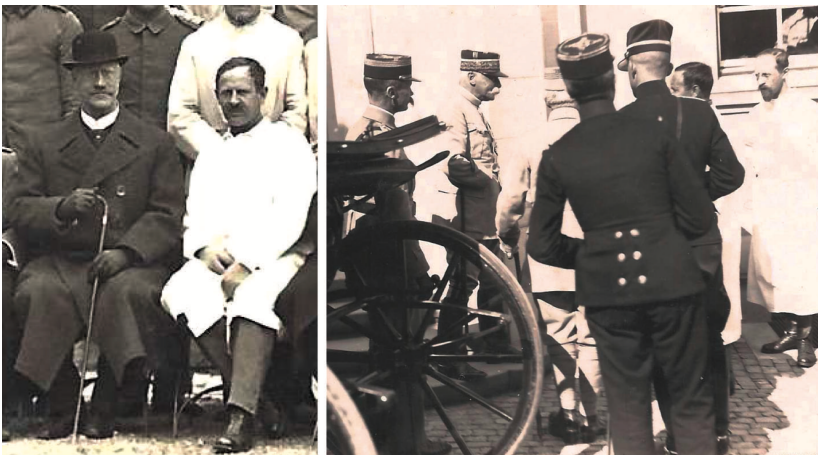


Fig. 9 (1917) Hans Brun (2nd from the right, partially hidden) with His Imperial Highness General Prince Alfons of Bavaria (left) and Marschall Philipp Petain (right) in front of the A.S.A. military hospital.

Contributions to the treatment of fractures and pseudarthrosis

Prof Dr Hans Brun's surgical experience led to an intensive scientific study of normal and disturbed bone regeneration [38, 40]. His monograph 'On the Diagnosis and Treatment of Late Complications from War Injuries', a collaborative work with the Zurich pathologist *Otto Busse* (1867-1922), was published in 1918. It presented an in-depth examination of bone regeneration and transplant, as well as the development, classification, and treatment of pseudarthroses based on extensive histomorphologic testing [8-10]. His classification of pseudarthroses (PA) according to their biological responsiveness [34] already anticipated in

part the following distinction between hypertrophic and atrophic pseudarthroses by Weber and Czech in 1973 [42].

Based on his histological-radiological investigations and surgical experience, Brun critically opposed the autogenous osteoplastic methods (osteosynthesis by bolting, onlay bone grafting, arthrodesis, inlay bone grafting, [15, 37, 47]) for treating pseudarthrosis at the time [40, 44]. Brun determined two causes for the often unsatisfactory results and technical difficulties, which had already received criticism from *August Bier* [3,4] and later *Melvin Henderson* [25, 26].

They were attributable to an insufficient biomechanical stability of the inserted bone grafts and a low biological self-healing propensity of the solid compact

bone graft during bone regeneration [15, 37, 40, 44].

Inlay bone grafting with fixation in the rectangular defect (1918)

Brun attempted to meet the postulate of improved stability for bone grafts without additional internal stabilisation with the 'Falzspan' [bone graft shaped to fit a rectangular defect] (1918) [8-10]. Contrary to the accepted scientific doctrine, which was valid until 1931 [29], he did not completely resect the pseudarthrosis (PA) but left a remaining portion of PA, which served as a scaffold for fixation of the pre-loaded bone graft. After preparation of a slot-shaped graft site and slight unfolding of the bone, a perfectly fitted graft harvested from the tibia was hooked and clamped into the cavity [40] (**fig. 10**).

Brun had recognised early on that cortico-spongy bone grafts were superior in their osteogenic potential to solid cortical transplants [8, 40]. Accordingly, he used cortico-spongy grafts that shared the greatest possible spongy surface area with the vital bone while simultaneously utilising the mechanical stability of the cortical bone [40]. Brun limited his onlay bone grafting technique to aseptic defects in pseudarthroses.

In 1918, Brun presented the method at the 1st congress of trauma surgery in Berlin. Even though the procedure exceeded previous methods of onlay bone grafting [28], such as the sliding graft arthrodesis [3, 4, 28, 29], in relative stability, bone

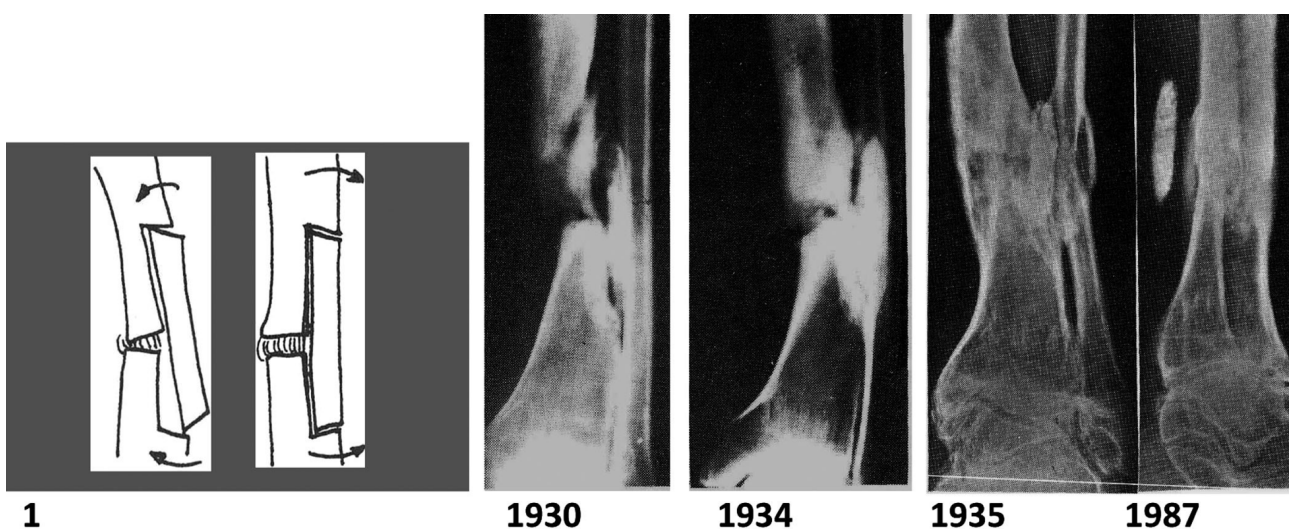


Fig. 10 1. Principle of graft fixation in the rectangular defect [40]. 2. Graft fixation in tibial pseudarthrosis surgery: Hans Brun, (1934) long-term follow-up (1934-1987).

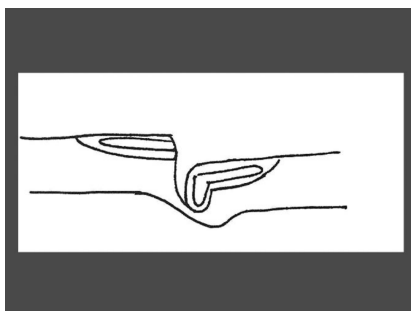


Fig. 11 Preparation of graft bed according to Brun (1927), original drawing by Matti (1936) [32].

continuity and improved graft integration, the response was fairly restrained. Whereas comments made by *August Bier* (1861-1949) and *Georg Hohmann* (1880-1970) were favourable, the reaction by *Erich Lexer* (1867-1937), on the other hand, was repudiating. It is likely that Brun's sceptical and critical assessment of the transplant results to date, along with the refusal to let him present the radiological findings of his cases — for reasons of censorship — were partly responsible for the lack of lasting attention [40].

Trench formation with cortico-spongious bone grafting (1927)

With the inception of the 'trench formation' method in 1927 [11, 40, 43], Brun intended to stimulate renewed callus formation and bone regeneration in radiologically-confirmed disrupted fracture healing (so-called delayed consolidation according to Brun, [11]), in the medullary cavity and periosteum. His approach contained two unique surgery-related elements, namely 'decortication' and 'formation of the graft site'.

The first element entailed that Brun kept the periosteum and the muscular mantle intact as a unit including chiselled cortical lamellae, thereby applying the method of decortication for the first time, albeit without using the term 'decortication' [33, 40]. As a surgical principle, this procedure was identical to the decortication published later by Dunn in 1939 [20] and can consequently be regarded as the earliest publication of this procedure [33, 40].

After debridement of the weak bone area, he fenestrated the proximal and distal cortex longitudinally and opened a groove or 'trench' that reached deep into the medullary cavity, which in turn formed a



1



2

3

Fig. 12 1. Principle of rotationplasty with spongiosa grafting [40]. 2. Rotationplasty in tibial pseudarthrosis surgery: Hans Brun, (1931). 3. Postoperative status. Integration of graft and spongiosa 18 weeks after surgery.

well-vascularised graft site [11]. He then filled it with chips of autogenous, cortico-spongious bone. With this method of graft site processing and bone void replenishment, Brun was ahead of his time [40] (fig. 11).

Rotationplasty with spongiosa grafting [1931]

The 'rotationplasty', presented by Brun in 1931, corresponded to his bone grafting method in terms of inlay bone grafting. The innovation encompassed the removal of a bone graft in the area of pseudarthrosis and reintegration of the graft following graft reversal so that the integral graft part bridged the pseudarthrosis [12, 13, 44] (fig. 12).

The method's critical step forward involved the filling of the remaining residual defect with autogenous spongiosa, which he derived in-situ from the wound surface area of the vital bone following debriding. With this approach, Brun was the first to combine osteoplasty using bone grafts with the transplant of spongiosa, thereby optimising the biological induction for bone healing. One year later in 1932, *Hermann Matti*, Bern (1879-1941), exclusively introduced spongiosa grafting as a new principle for the positive filling and bridging of bone defects and fracture healing disorders [30-32, 47]. Additionally, he confirmed the superior healing dynamics of the spongiosa for bone regeneration [5, 18, 19, 22].

It seems that *Matti* and *Brun* almost simultaneously recognised the significant

biological osteogenic potential of spongiosa. Given the fact that *Matti's* concept was more consistent and successful, Brun's approach quickly faded into obscurity.

Influences on modern therapy

While they partly preceded future developments, both methods, the combination of graft bed preparation with cortico-spongious bone grafting (1927) and the rotationplasty with spongiosa grafting (1931), were not met with a significant response [24, 40]. *Hans Willenegger*, who had worked closely with *Otto Schürch* in Basel, reported in 1992 that *Otto Schürch* (1896-1951) — a pupil of *Paul Clairmont* (1875-1942, Zurich) — was the only one to apply Brun's rotationplasty as a standard method with unflinching success. First, he worked at the cantonal hospital Winterthur (1936-1947) and then as a professor of surgery at the university hospital Basel (1948-1952) [40, 46].

Hermann Matti (1879-1941), Bern, and later *Hans Willenegger* (1910-1998), Liestal, one of the later co-founders of the AO Foundation, were the first to adopt a selection of Brun's operating techniques, which — after further development — found their way into modern fracture treatment. Thus, *Hermann Matti* adopted Brun's decortication and graft bed preparation in preparation for his spongiosa osteoplasty. Furthermore, he retained residual tissue of malunions in the treatment of pseudarthrosis [40, 41]. Both surgeons (*Matti/Willenegger*) made reference to their adoption of original



Fig. 13 (1925) Hans Brun (right) at the top of the Jungfrau 4,158 m above sea level.

methods by Hans Brun in their early publications [40]. So it comes at no surprise, that both surgeons were close friends with Hans Brun. Moreover, *Hans Willenegger* frequently worked as a guest surgeon with Hans Brun in Lucerne in the early 1940s [40].

Facets of a medical personality

Hans Brun is one of the founding members of the ‘Schweizerische Gesellschaft für Chirurgie’ (SGC) [Swiss Society for Surgery (SSC)] (*1913), whose honorary member he became in 1938. Brun was widely known in Switzerland. Above that, he was extremely popular among medical colleagues and patients alike [14, 24, 40, 45]. Many of his fellows sought his advice, both for private and professional matters [14]. He was known among professional peers for his pioneering position concerning orthopaedic and trauma surgery, his strict asepsis, his tissue-conserving surgeries, and the peculiarity of performing all operations personally [40, 45].

He shared a close friendship with *Paul Clairmont* (1875-1942), director of the university hospital for surgery in Zurich from 1918 until 1941, along with his successor *Alfred Brunner* (1890-1972), director from 1941 until 1961; both of whom had great respect for Brun [14, 24, 40].

As an enthusiastic alpinist and climber, he was among the founders of the ‘Akademischer Alpen Club’ [Academic Alps Club] - Zurich (AACZ *1896), he climbed all 48 peaks above 4,000 metres in the Swiss Alps and was appointed an honorary member in 1930. A route that ascends the Windgällen (3,187 m) (Maderanertal), Uri bears his name [24] (fig. 13).

Brun's passion for music should not be left unmentioned. His dedication to the invitation of the conductor *Arturo Toscanini*, whom he — a speaker of Italian —, with the help of other personalities, persuaded to come to Lucerne, will remain unforgotten. Toscanini's engagement — the ‘Concert de Gala’ — on the 25th of August 1938 inside the park in front of Richard Wagner's Villa ‘Tribtschen’ in Lucerne, marked the beginning of today's ‘International Lucerne Festival’.

Hans Brun had little time for his family, his clinical and surgical activity was too captivating. The latter is documented in his farewell lecture, held in 1942 in the traditional surgical lecture hall of the University of Zurich. He anticipated future institutional-structural developments and the resulting problems and demands on surgery:

‘The materialistic time of today, the interference from [...] state institutions

and the ever-increasing loss of personal responsibility [...] entails a developmental direction, which in many ways is alien to the surgical tradition [...]’. Nevertheless, he propagated the adaptation to the coming changes without giving up on necessary research along with genuine surgical empathy and warned of a purely technical understanding of surgery.

Epilogue

Hans Brun recognised early on that the continuity of the bone — where healing is absent or in the case of defect pseudarthrosis — can be favourably influenced by increasing stability, improving vascularization (decortication), and by inducing osteogenesis utilising autogenous spongiosa. These realisations as clinical researcher and surgeon made him, in fact, a pioneer in the treatment of fractures and pseudarthrosis.

At his time, Hans Brun established himself, with the osteoplastic techniques he developed, as a highly innovative surgeon.

It remains to be seen whether the self-critical presentation of his results or rather the single publication in Swiss professional journals was responsible for the poor response to his procedures. At least his clinical results and findings were adopted and further developed by later pioneers of surgical fracture treatment, demonstrating that Hans Brun can be classified as one of the pioneers of modern surgical fracture treatment.

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