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A Historical Report on Riccardo Galeazzi and the Management of Galeazzi Fractures

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Abstract

Fracture of the shaft of the radius associated with a dislocation of the distal radio-ulnar joint is an uncommon injury. In 1934, Riccardo Galeazzi of Milan reported his experience with the management of 18 such cases before the Lombard Surgical Society and subsequently received the eponym for this injury. Galeazzi was one of Italy's pioneering orthopedic surgeons, with an extensive bibliography that included nearly 150 publications. This article examines the evolution of management of the Galeazzi fracture and sheds light on this notable physician's life.

Keywords

Riccardo Galeazzi; Galeazzi's fracture; distal radio-ulnar joint dislocation; radius shaft fracture; forearm fracture

The Galeazzi fracture is an unstable fracture-dislocation of the forearm that includes a fracture of the shaft of the radius and a dislocation of the distal radio-ulnar joint (DRUJ).[1] In addition, certain injuries are considered as a Galeazzi's equivalent. These include, in children, a fracture of the radial shaft associated with a separation of the distal ulnar epiphysis without a disruption of the DRUJ,[1] and in adults, a fracture of the radial shaft associated with an additional fracture of the distal ulna.[1, 2]

This fracture pattern was first described by Cooper in 1822,[3] but it is Galeazzi, who in 1934 presented a series of 18 patients with this injury, and elaborated on the incidence, pathomechanics, and management.[4, 5] This fracture is also eponymically referred to as a reverse Monteggia fracture,[2] a Piedmont fracture,[2] a Darrach-Hughston-Milch fracture,[6] and a fracture of necessity.[7] A PubMed search for the term 'Galeazzi fracture' returned a little over 100 results. On the contrary, little has been written about Galeazzi himself. A PubMed search for 'Riccardo Galeazzi' returned only two results.[8, 9] This paucity of information is not surprising because almost all of Galeazzi's publications are in Italian and German. We

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undertook an extensive literature search, contacted the Archives at the University of Milan, and secured a copy of his curriculum vitae from 1933.[10] In addition, we translated his original articles that described the Galeazzi fracture,[4, 5] and two biographical articles published in the Italian literature.[11, 12] We also secured a copy of Coopers' article from 1825 describing this injury.[3] From these original materials, we present the management of the Galeazzi fracture over two centuries, and summarize the life and contributions of Riccardo Galeazzi.

GALEAZZI AND HIS FRACTURE

Professor Riccardo Galeazzi was one of Italy's most distinguished orthopedic surgeons who contributed to clinical and academic medicine in many ways.[8–12] He served as Director of the Institute for Crippled Children at Milan, Professor of Clinical Orthopedics and Traumatology, and Dean at the University of Milan. He also directed the Archivio di Ortopedia, the oldest periodical devoted to Orthopedic Surgery for 35 years. This journal was for many years the official journal of the Italian Orthopedic Society. His bibliography is extensive and includes nearly 150 publications that contributed in various fields of Orthopedic Surgery, including his three greatest contributions: the correction of scoliosis by manipulation and splinting, the surgical treatment of recurrent dislocation of patella, and the description of the fracture of the radial shaft associated with dislocation of the DRUJ.

Galeazzi published two articles describing the fracture of the radius associated with a dislocation of the distal radio-ulnar joint. The first article was published in Italian in 1934[4] and the second was published in German in 1935.[5] Galeazzi presented the largest series (n=18) of this injury at that time, and cited an incidence of 6% in his series of 300 forearm fractures. He reported this injury as occurring more frequently compared to the Monteggia fracture (2%) and described the mechanism of this injury as being similar to the Monteggia fracture. His description of the mechanism was as follows[5]

"……when a person falls on his hand and fractures the radius, the weight acts longitudinally on the ulna because of the sudden superposition of the radius fragments. The ulna in proportion to the radius becomes too long and bends inevitably. If the bone does not resist the force of longitudinal energy, it breaks. However when the bone resists the force, it is forced to luxate at the lower end, as the upper end is connected very strongly to the humerus. Another cause of luxation is muscle movement, which does not happen at the moment of actual trauma, but rather a few days later. The distal fragment of the radius pronates and comes closer to the ulna through the action of the pronator quadratus and adductor pollicis longus and extensor pollcis brevis. These move the distal fragment around in a spiral manner in the space between the two bones and to the volar side….. I believe that the fracture happens first and the luxation is the outcome of it."

Galeazzi was the first to appreciate that the radius fracture was linked to the DRUJ dislocation and that both needed to be addressed simultaneously. However his management of the injury by closed reduction and splintage was suboptimal and resulted in recurrence of the DRUJ subluxation.[5] It is easier to understand the mechanics of forearm fracture dislocations (Monteggia, Galeazzi and Essex-Lopresti), if we consider the radius, the ulna

and the proximal and distal radio-ulnar joints as forming a stable ring made of 4 components. An injury involving more than one component makes the ring unstable, and one must recognize, and appropriately address, all components to restore function. In fractures of the radial shaft, an associated injury to the DRUJ may be quite subtle. As attention is immediately drawn to the more obvious shaft fracture, a Galeazzi injury may be missed on initial emergency room presentation.[13] Although isolated radial shaft fractures are more common compared to a true Galeazzi fracture, surgeons should take great care not to overlook injury to the distal or proximal radioulnar joint.[14]

EVOLUTION OF MANAGEMENT OF THE GALEAZZI FRACTURE

The evolution of the management of the Galeazzi fracture can be better understood by dividing it into three periods. In the early period (1822–1940), although both components of the Galeazzi fracture were identified and addressed simultaneously, they could not be stabilized rigidly as appropriate techniques of internal fixation were not available. In the intermediate period (1941–1985), the availability of rigid internal fixation techniques made the management of the radial shaft definitive, but the management of the DRUJ continued to be contentious. In the current period (1986–2010), with better understanding of the ligamentous anatomy of the DRUJ and improved tools to evaluate it, it has become clearer that certain fracture patterns and fracture locations are more prone to have an associated injury to the DRUJ.

A. Early period (1822–1940)

The management of the Galeazzi fracture in the 19th and early part of the 20th century essentially consisted of reduction of the radius shaft fracture (open or closed), reduction of the DRUJ (open or closed) (if this injury was recognized), and splinting (Fig. 1). However a good anatomical reduction did not necessarily ensure a superior result because the fixation was often inadequate. The unstable nature of this injury meant that both the fracture and the DRUJ would eventually displace, which resulted in a malunited radial shaft and severely limited prono-supination. The first report of a fracture of the shaft of the radius associated with a dislocation of the distal radio-ulnar joint was by Sir Astley Cooper in 1822.[3] He described this injury as occurring frequently in his practice and the great difficulty he had in reducing and maintaining the reduction. Interestingly, he noted that a greater obliquity of the radial shaft fracture resulted in greater displacement of the radius fragments, which resulted in dislocation of the ulna. Darrach in 1912 reported a 20-year-old man with an 8-week-old fracture of the radial shaft two and a half inches above the lower margin with anterior bowing and a forward dislocation of the head of ulna.[15, 16] After an unsuccessful attempt at closed reduction of the ulnar head, Darrach made an incision over the anterior aspect of the ulna, reduced the head and maintained the reduction by a splint in pronation. He noted that one and a half years later, although the patient recovered good finger and wrist motion, he was unable to pronate or supinate his forearm. Based on his experience with this case, Darrach recommended sub-periosteal excision of the distal end of the ulna for delayed cases of ulnar head dislocation. This method became popular as the Darrach procedure and is still recommended in late cases of Galeazzi's fracture.

In 1922, Homans et al. reported on 6 cases of fracture of the lower end of the radius associated with either a fracture of the ulnar shaft or dislocation of the lower end of the ulna.[17] He noted that in spite of open reduction of the radius fracture, and a well applied splint, there was a tendency to angulation and delayed union in the cases associated with a dislocation of the radioulnar joint. Cotton FJ (1924) also felt that the presence of a DRUJ dislocation in patients with a fracture of the radius led to substantially poorer outcomes.[18] In order to improve outcomes in these cases, Wilson and Cochrane (1925),[19] and Milch (1926)[20] reconstructed the radio-ulnar ligaments and the triangular fibrocartilage with a fascial graft, whereas Valande (1929)[21] performed an open reduction and fixation of the radial shaft using wire loops. Despite these surgical interventions, the results were poor. The next two reports in literature were by Galeazzi, whose treatment was conservative.[4, 5] He reduced the radial shaft fracture by pulling on the thumb with the forearm in the supinated position, the ulnar head by radially deviating the wrist, and maintained the reduction using a plaster of Paris cast. Galeazzi did not report the functional outcome of his treatment, but mentioned that if the ligaments of the DRUJ were torn, the DRUJ would subluxate after a certain time.[5] Bohler (1935) pinned the DRUJ using K-wires to maintain the reduction of the DRUJ, and to allow the torn ligaments to heal and reported a good functional result.[22]

B. Intermediate period (1941–1985)

With the introduction of instrumentation for rigid internal fixation, everyone agreed on the need for rigid fixation of the radial shaft fracture. However there was little agreement with regards to the DRUJ (Fig. 2). Different options were offered ranging from simple splinting, pinning of the DRUJ, to excision of the distal ulna. Hughston in 1957 reported a series of 41 cases that were studied by the Piedmont Orthopedic Society (composed of members of the Duke University Orthopedic Training Program, Durham, North Carolina and was formed to investigate clinical orthopedic problems; hence the eponym's Piedmont fracture and Darrach-Milch-Hughston fracture).[7, 23] The Piedmont Society studied 41 Galeazzi fractures, of which 38 were managed conservatively, and 3 managed with surgery. They classified their results as satisfactory if there was union, perfect alignment, no loss of strength, no subluxation of the distal radio-ulnar joint, and no limitation of pronation or supination. Of the 38 fractures treated conservatively, 35 (92%) resulted in failure. Hughston concluded by noting that this fracture pattern was difficult to manage by closed reduction. He suggested open anatomical reduction and rigid internal fixation of the radius, testing the stability of the DRUJ, and comparing it with the opposite normal side. If it were unstable, he recommended resection of the distal ulna.

Wong (1967) was unable to achieve a satisfactory outcome in his series of 44 cases of Galeazzi fracture and felt that an excision of the distal ulna should be considered in all late cases.[24] Mikic in 1975 reported the largest series of Galeazzi fractures (n=125) to date.[1] Although he agreed with open reduction and rigid fixation of the radius, he felt that immediate excision of the distal ulna was too aggressive. He recommended temporary fixation of the radio-ulnar joint with one or two K-wires. Reckling et al. reported on 23 cases of Galeazzi fracture in 1968 and an additional 24 cases in 1982.[8, 25, 26] He felt temporary fixation of the DRUJ with K-wires was not required. Instead he advocated immobilization of the forearm in full supination for 6–8 weeks. Mestdagh et al. (n=29)[27] and

Moore et al (n=36)[28, 29] also felt that temporary pinning of the DRUJ was rarely required, and preferred immobilization in a mid prone or slightly supinated position for 4 weeks. Kraus et al. reviewed their series of 27 Galeazzi fractures treated by open reduction and rigid internal fixation of the radius and found that the application of a plaster cast did not affect the results of treatment and recommended no immobilization of the forearm or elbow.[30]

C. Current period (1986–2010)

This controversy in the management of the DRUJ and the discrepancy in results obtained by different surgeons made it apparent that something was amiss (Fig. 3). Chattopadhyay et al. classified Galeazzi fractures into Type A and Type B based on the slope of the radius fracture.[31] In a type A fractures, the fracture line travelled from above downwards and laterally, whereas in a type B fracture, the fracture line travelled from above downwards and medially (radiograph viewed with digits pointing inferiorly). In their opinion the Type A fracture was much more unstable and needed a careful evaluation of the DRUJ and pinning or splinting the DRUJ in addition to rigid fixation of the radius. Beneyto et al. in a series of 33 Galeazzi fractures divided their fractures into three types based on the distance of the fracture from the radial styloid.[32] A type-I fractures was within 10 cm from the styloid, a type-II fracture was 10–15cm from the styloid, and type-III fracture was greater than 15 cm from the radial styloid. Their worst results were obtained in the type-I lesion, and they recommended pinning of the DRUJ and immobilization in full supination in this group.

Rettig et al. in 2001 presented the results of open reduction and internal fixation of the radial shaft fracture in 40 patients with Galeazzi fractures.[33] They found that out of the 22 fractures that were within 7.5cm of the mid-articular surface of the distal radius (Type I), 12 (55%) had intra-operative DRUJ instability after rigid fixation of the radial shaft fracture and needed pinning of the DRUJ. On the contrary, only 1 out of the 18 (6%) fractures that were greater than 7.5cm away from the mid-articular surface of the distal radius (Type II) had DRUJ instability. They recommended evaluation of the stability of the DRUJ in supination after rigid fixation of the radius in all cases of Galeazzi fracture, K-wire stabilization in cases with instability and to be suspicious for residual DRUJ instability in Type-I fractures. Giannoulis et al., in a review article written in 2007, proposed an algorithm for management of Galeazzi fracture dislocation based on the stability of the DRUJ after rigid internal fixation of the radius shaft.[2] They tested the stability by attempting to translate the ulnar head dorsally out of the sigmoid notch with the forearm in supination. If the DRUJ was stable, they pinned the DRUJ using 2 K-wires in neutral or mild supination. If it were unstable, they recommended repair of the TFCC and pinning in neutral rotation. If the unstable DRUJ was associated with an ulnar styloid fracture, they recommended fixation of the styloid using a tension band wire or a lag screw. If the DRUJ were irreducible, they recommended open reduction to remove the interposed soft tissue and TFCC repair. They placed all patients with a Galeazzi fracture in a long arm cast for 4–6 weeks and started active and passive exercises of the elbow, wrist and forearm after cast removal.

GALEAZZI'S LIFE AND CONTRIBUTIONS

Riccardo Galeazzi (Fig. 4) was born in Turin on 17th August 1866. His parents Cesare and Annetta Artesana were from the Liguria province of Italy. He entered the University of Turin Medical School in 1886 and graduated with honors on 21st July 1890. His surgical career began at the L'Ospedale Mauriziano Umberto Primo, Turin as an assistant to the founder of surgery at Turin 'Prof Antonio Carle'. He qualified as a lecturer in Clinical Medicine and Surgical Operations in 1899 and became faculty at the University of Turin, and demonstrated surgical pathology, in addition to his duties as a clinical surgeon. He married Bianca Negri (born 15th February 1880) on 5th September 1901 and they had five children. Anna was born at Turin, while Paola, Cesare, Luisa and Luigi were born at Milan.[10]

In 1903, after a competitive examination, he was appointed as Director of the Pius Institute for Crippled Children (Istituto dei Rachitici) (Fig. 5) at Milan. This institute soon grew from a small clinic to a large institute for the study and treatment of crippled children.[34, 35] He started teaching at the Orthopedic Institute at the University of Milan in 1906, and became Professor of Clinical Orthopedics and Traumatology in 1908. Under his direction, the number of beds of the Orthopedic Institute grew from 55 to 300, and specialized sections on radiology, physical rehabilitation, physiotherapy, prosthetics, mechanical devices, and research laboratory were added.[11] This orthopedic institute was renamed as the Istituto Ortopedico Galeazzi in 1961 to honor the contributions of Riccardo Galeazzi. It is now a center of excellence for basic research, pre-clinical and clinical research of diseases of the musculoskeletal system.

His major field of interest was scoliosis, for which he developed a method of derotation of the spine.[36] He had more than 20 publications related to scoliosis and his body of work on scoliosis was published in a monograph titled 'The pathogenesis and treatment of scoliosis" in 1948. His other fields of interest included the treatment of tuberculosis, particularly Pott's disease, the pathology of destructive hip arthritis in infants, and osteochondritis and osteoarthritis deformans of youth. His contributions to the treatment of chronic arthritis in adults included experimental studies on bone grafting and transplantation of epiphyseal cartilage. He studied the pathology of osteitis fibrosa and achondroplasia. He had a vast experience of treating over 12,000 cases of congenital dislocation of the hip since 1911. He had detailed clinical and experimental studies on the pathophysiology of meniscal and ligament injuries of the knee.[37] In the field of operative surgery, he introduced original techniques for the correction of knee valgus deformities, ankylosis of the knee, poliomyelitic deformities, and congenital foot deformities. He established the use of muscles and tendons in treating recurrent dislocation of the shoulder, the patella, and torn cruciate ligaments of the knee, and was one of the pioneers in the diagnostic use of x-ray.[9, 11]

Galeazzi's work was recognized by the conferment upon him of many honors, both in Italy and in many foreign countries. He was president of the Italian Society for Orthopedic Surgery on four occasions, and honorary member of the American, British, Belgian, French, and German Orthopedic Societies. He was a founding member of the International Society of Orthopedic Surgery and Traumatology (SICOT) (Fig. 6) and advisor to the International

Society for crippled Children. He was awarded the Gold medal of merit on 2nd December 1934 by the University of Milan in recognition of his 30 years of teaching and management of the Istituto dei Rachitici. To commemorate this occasion, his friend and colleague Dr Vittorio Putti released a volume of his important medical writings.[11]

Galeazzi participated as a volunteer in World War I and was instrumental in the establishment of vocational rehabilitation centers for Italian soldiers wounded in World War I. However Galeazzi's greatest contribution to modern medicine was the vocational rehabilitation of disabled workers.[38] With rapid industrialization and lack of safety norms, industrial injuries were commonplace and Galeazzi was among the first and probably the most influential advocate of moral assistance from the company for injured workers. He was instrumental in starting a clinic for occupational disorders at Milan (Fig. 7). This clinic 'For the Scientific Study of Prevention of Occupational Diseases' familiarized physicians with the subject, and sheltered men injured at work for diagnostic and therapeutic purposes. The secretary of the American Association for Labor Legislation, John B Andrews wrote in 1910[38]

'Some of us had hoped that industrial America, with its wonderful resources, its famed philanthropies, and its uncounted thousands of work diseased men and women, might be first among nations to recognize the need of a special hospital and clinic for industrial diseases…But the honor belongs to Italy….When Florence Nightingale and Henri Dunant saw the battle-filed strewn with dead and wounded, they gave a moment and then passed on to the world an idea which grew into that beneficent organization known as the Red Cross. Since that time wherever men might be injured in the activity of war the means for quick relief have been supplied. During the same half century, however, the industrial field with its activities of peace has extended and grown more mechanical, until it maims now more men than war ever did.'

Galeazzi died in Milan on 26th February 1952. His many writings testify to his intellect and scientific acumen. His example and leadership, both in clinical surgery and in research were a tremendous stimulus to progress of Orthopedic Surgery throughout Italy. His influence was largely responsible for the inception and development of rehabilitation centers for the care of the crippled and injured.[9] To Hand Surgery, he provided the description and mechanism of the Galeazzi fracture, but more significantly, he gave us a system for recognizing and treating injuries arising at the workplace.

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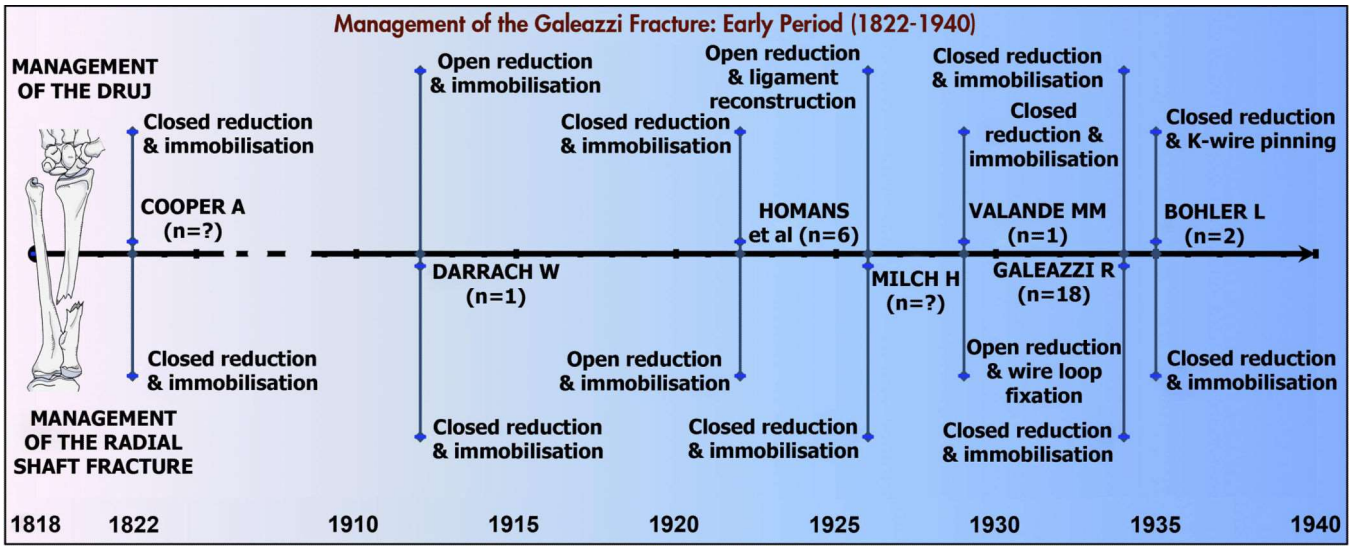

Figure 1.

Early period (1822–1940) of management of the Galeazzi fracture (Picture of Galeazzi fracture reproduced and adapted with permission from the Radiological Society of North America, Figure 14, Hunter T B, Peltier L F, Lund P J. Radiologic history exhibit: musculoskeletal eponyms: who are those guys? Radiographics 2000;20:736–819.)

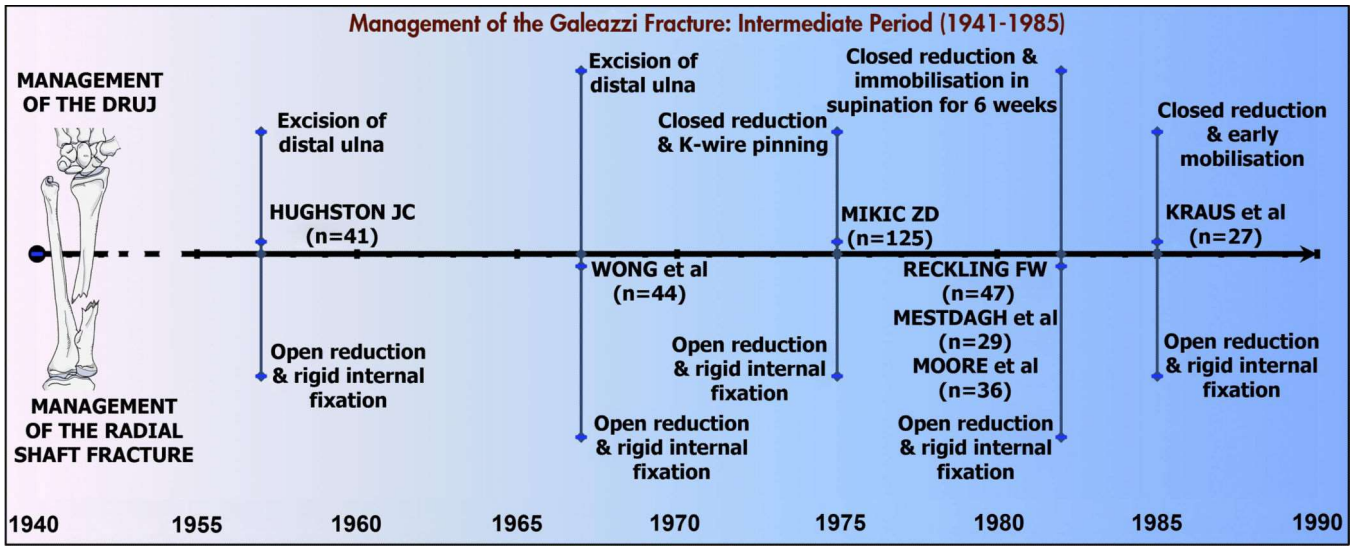

Figure 2.
Intermediate period (1941–1985) of management of the Galeazzi fracture

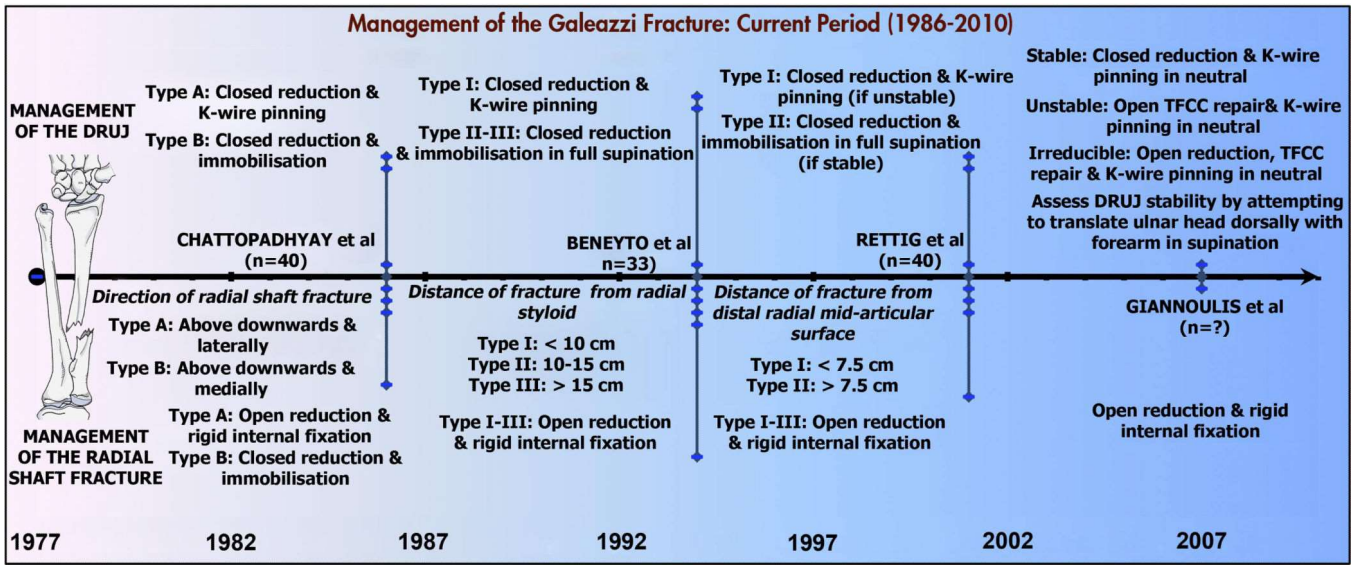

Figure 3.

Current period (1986–2010) of management of the Galeazzi fracture

Figure 4.

Riccardo Galeazzi (1866–1952)[9] (Reproduced and adapted with permission and copyright © of the British Editorial Society of Bone and Joint Surgery, Scaglietti O. In memoriam: Riccardo Galeazzi. J Bone Joint Surg 1953;35B:679–680)

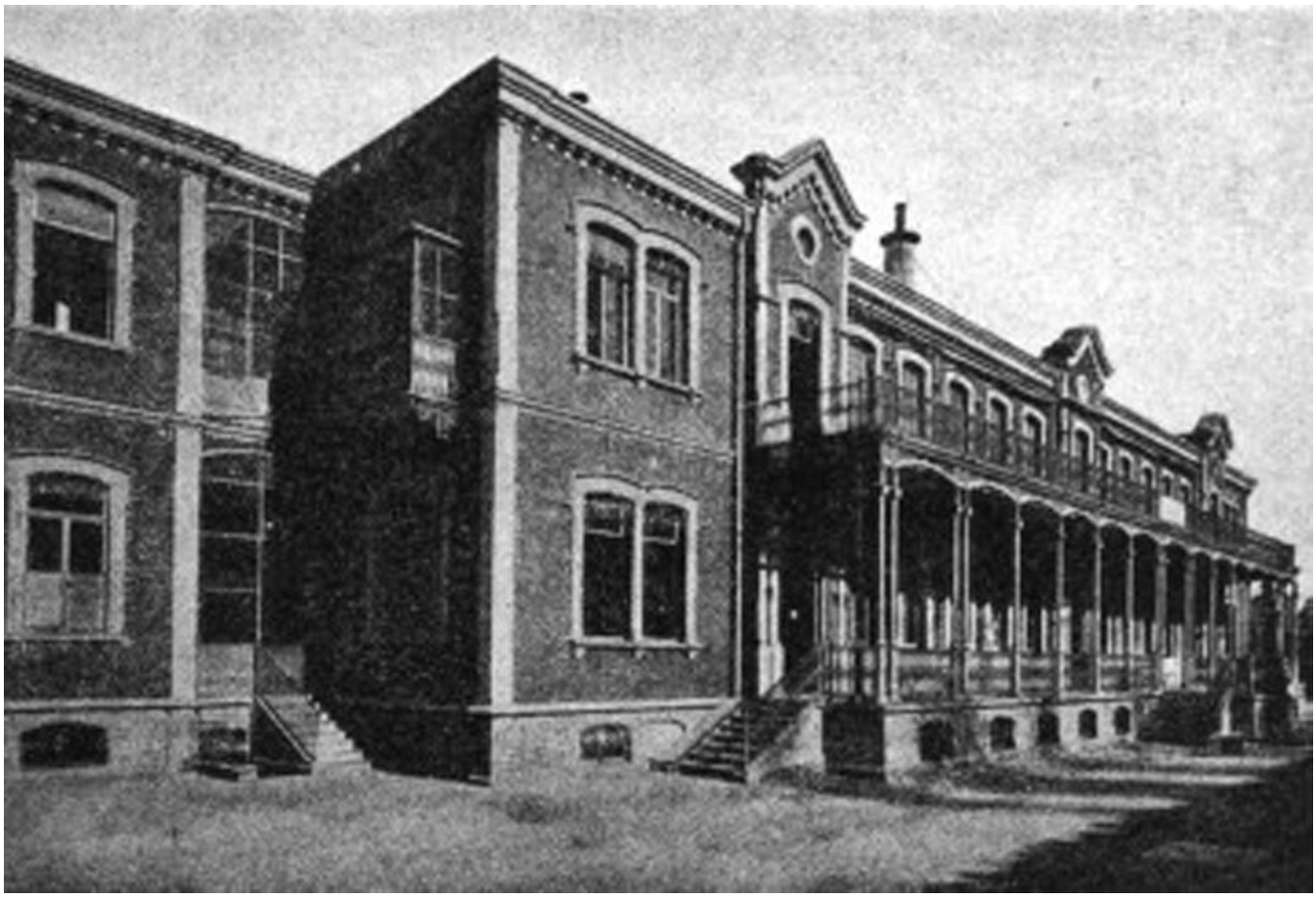

Figure 5.
Istituto dei Rachitici, Milan[35] (http://books.google.com/books?id=qWQJAAAAIAAJ&dq=Modern%20Italian%20Surgery%20and%20Old%20Universities%20of%20Italy&pg=PA79#v=onepage&q&f=false)

Figure 6.
Founders of the International Society of Orthopedic Surgery and Traumatology (SICOT) at Hotel Crillon, Paris, France on 10th October 1929 (http://www.sicot.org/?id_page=3)

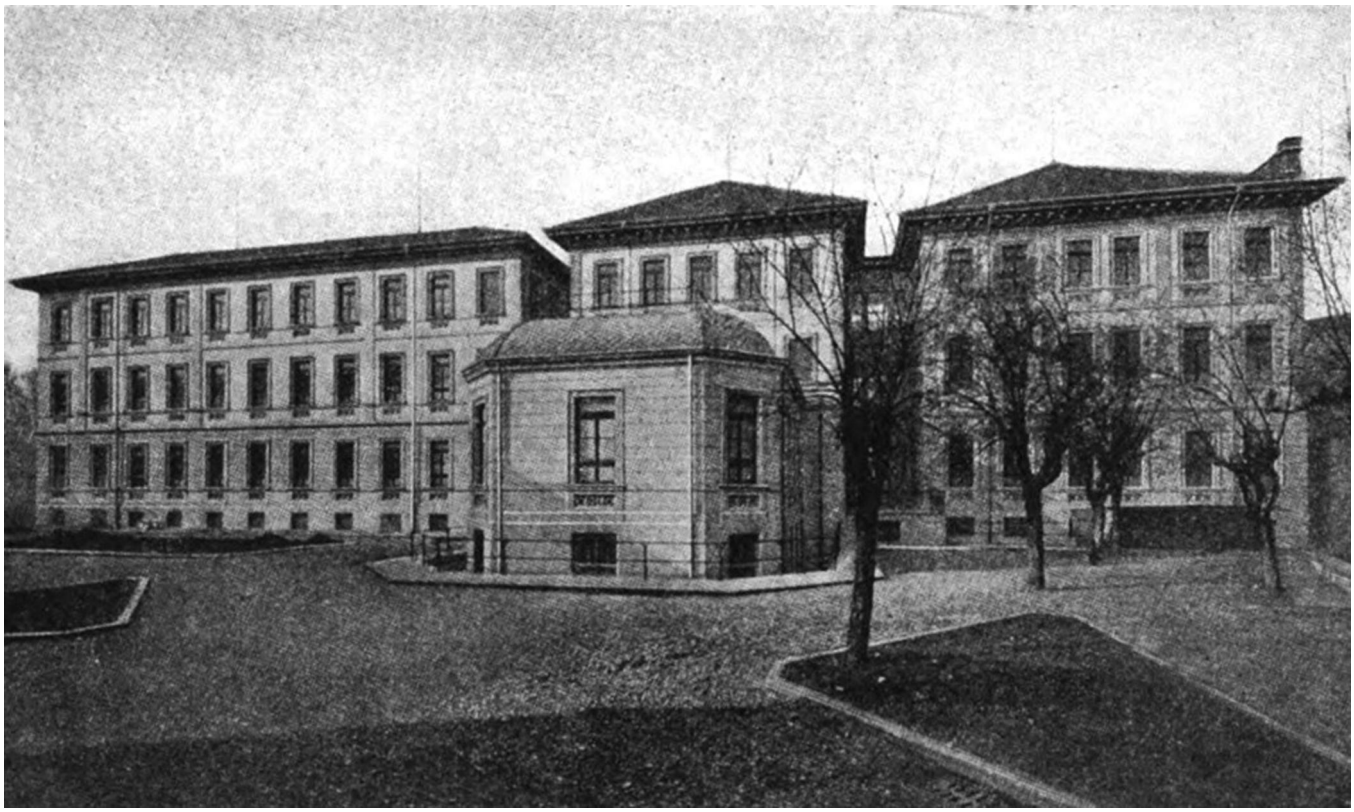

Figure 7.
Clinic for Occupational Diseases, Milan (circa 1911)[38] (http://books.google.com/books?id=qWQJAAAAIAAJ&dq=Modern%20Italian%20Surgery%20and%20Old%20Universities%20of%20Italy&pg=PA159#v=onepage&q&f=false)