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# History of the treatment of scapula fractures

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**Abstract** The history of treatment of scapula fractures is closely connected with the history of the French surgery. Paré (Les œuvres d´Ambroise Paré, conseiller, et premier chirurgien du Roy, Gabriel Buon, Paris, p VCV, 1579), Petit (Traité des maladies des os. Tome second, Charles-Etienne Hochereau, Paris, pp 122–138, 1723), Du Verney (Traité des maladies des os. Tome I, de Burre, Paris, pp 220–231, 1751) and Desault (Œuvres chirurgicales, ou tableau de la doctrine et de la pratique dans le traitement des maladies externes par Xav. Bichat, Desault, Méquignon, Devilliers, Deroi, Paris, pp 98–106, 1798) were the first to point out the existence of these fractures. The first drawing of a scapula fracture was presented by Vogt (Dissertatio de ambarum scapularum dextroeque simul clavicularae fractura rara, Dissertatione Universitae Vitembergensi, Wittenberg, 1799). This author was also the first to describe the scapula fracture associated with ipsilateral fracture of the clavicle. The first radiograph of scapula fracture (glenoid fossa fracture) was published by Struthers (Edinburgh Med J 4(3):147–149, 1910). The first internal fixation of scapula fracture using plate was done by Lambotte (1910) who was followed by Lane (The operative treatment of fractures, Medical Publishing Co, London, pp 99–101, 1914) and later by Lenormant (Sur l´ostéosynthèse dans certains fractures de l´omoplate Bulletins et mémoires de la Société de chirgie de Paris, pp 1501–1502, 1923), Dujarier (Fracture du col chirgical de l´omoplate. Ostéosynthèse par plaque en T. Bonne réduction. Bulletin et mémoires de la Société de chirurgie de Paris, pp 1492–1493, 1923) and Basset (Ostéosynthèse d´une fracture de l´omoplate. Bulletin et mémoires de la Société nationale de chirurgie. p 193, 1924). Dupont and Evrard (J Chir (Paris) 39:528–534, 1932) presented the first detailed description of the surgical approach along the lateral border of the scapula including two drawings. They were also the first to use the term "pillar of scapula". Judet (Acta Orthop Belg 30:673–678, 1964) advocated operative treatment of displaced scapula fractures and described extensile posterior approach. Based on the French school, AO/ASIF improved methods of internal fixation of these fractures.

**Keywords** Scapula · Scapula fractures · History of scapula fractures

## Introduction

Operative treatment of scapula fractures has been the subject of a number of publications [6, 10, 12, 16–18, 24, 39, 51, 62, 65, 73, 82, 94, 97, 104, 108, 112, 123, 124, 127, 128, 131, 132, 138, 139, 143, 146] yet little is known about its history. Only a few articles [2, 3, 16, 105, 144] briefly refer to the Desault′s publication of 1805 [30]. The same applies to textbooks of shoulder surgery [52, 70] or history of orthopedics [117]. Analysis of original sources has revealed that the history of scapula fractures started actually much earlier, as early as in sixteenth century, and is much richer than previously described.

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## The oldest references (1579–1798)

The first information concerning scapula fractures may be found in the works of outstanding French surgeons of sixteenth through eighteenth century.

The oldest description of a fractured scapula caused probably by a war injury was presented by Ambroise Paré (1510–1590) in 1579 [113, 115]. Paré, the personal physician of four French kings, stated *"…in case of fracture, if the parts move and prick the flesh, an incision should be made to remove them with a "bec de corbin"(special device named "beak of crow"). But if the pieces of bone do not prick the flesh and are still attached to the periosteum, they need not to be removed since they will heal. If they are completely free from periosteum, they have to be removed because anyway they will be ultimately forced out, since they do not live anymore and, as stated by Hippocrates, "the living will always oust the dead". When the fracture involves the neck of the scapula the prognosis is almost always fatal, as was also the case of some famous people, for instance the King of Navarre…".*

Jean-Louis Petit (1674–1760), an extraordinary French surgeon, dealt in detail with scapula fractures in his work *"Traité des maladies des os"* [118] published in 1723, distinguishing between fractures of the body, neck and processes of the scapula (acromion, coracoid, spine). He subdivided fractures of the scapula body into transverse, oblique, and longitudinal ones. He provided the first recorded description of subcutaneous emphysema associated with scapula fractures and discussed the possibility of fracture of the glenoid rim associated with dislocation of the humeral head. For fixation of scapula fractures he used a bandage of his own design (Fig. 1). He was also the first to make an allusion to a kind of early physiotherapy by "*changing the apparatus more often than for other fractures to give some motion to the limb"…"This is also an advantage because motion provides the limb capsule and the neighbouring ligaments by easiness and freedom"*

Joseph-Guichard Duverney (1648–1730), a French anatomist and surgeon, likely preceded Petit but his works under a similar title *"Traité des maladies des os"* [34, 116] were published by his pupils only after his death in 1751. He used the same classification of the types of scapula fractures as Petit. He was also the first author to describe a fracture of the scapular neck, revealed by autopsy, in a 20-year-old woman.

Posthumous works "*Œuvres chirurgicales, ou tableau de la doctrine et de la pratique dans le traitement des maladies externes*" [29] of another prominent French surgeon Pierre-Joseph Desault (1738–1795), edited by his pupil Marie Francois Xavier Bichat (1771–1802) and published in 1798, marked a watershed in the development of surgery at the turn of the nineteenth century. Desault, the founder of

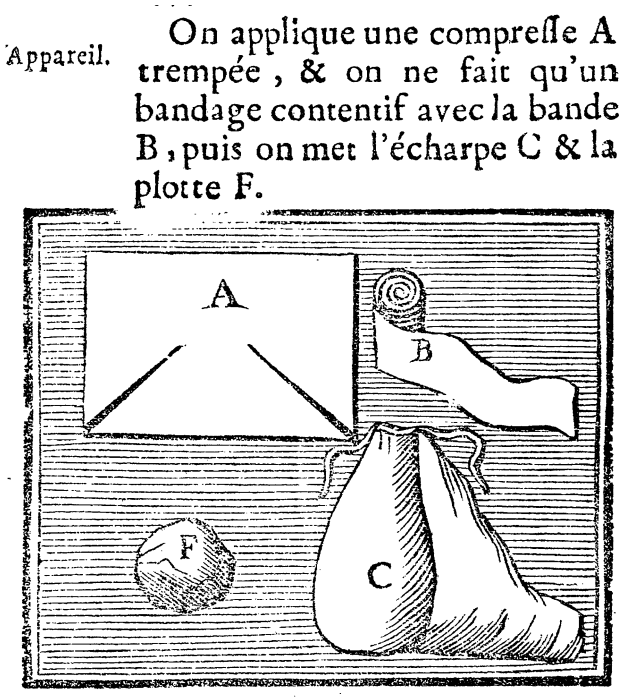


**Fig. 1** Petit's original drawing of his bandage

the first surgical journal in the world described, on the basis of case histories, the fracture of acromion and fracture of the inferior angle of the scapula. His text contained also an original drawing of the Desault bandage designed by the author for fixation of fracture of the clavicle and scapula (Fig. 2). The book was promptly translated into English and published in the United States in 1805 [33]. As a result, the American edition is often mistakenly cited as the original source containing the first mention of the scapula fracture [2, 3, 16, 105, 144].

## Clinical–anatomical period (1800–1895)

Publications dating back to this period were based for the most part on detailed descriptions of different cases, starting with the mechanism of the trauma, the clinical course until the patient′s death with a special focus on autopsy findings. Scapula fractures were treated exclusively non-operatively and discussions concentrated only on how and in what position the injured extremity was to be immobilized.

The first study devoted solely to scapula fractures was published by Traugott Karl August Vogt (1762–1807), professor of Wittenberg University, in 1799 and 1800 [141, 142]. The study containing a precise anatomical description of the scapula, its muscles, blood vessels and nerves, was based on the case of a bilateral scapular fracture. The fracture of body of the right scapula was associated with fracture of the clavicle. The original drawing (Fig. 3) presented

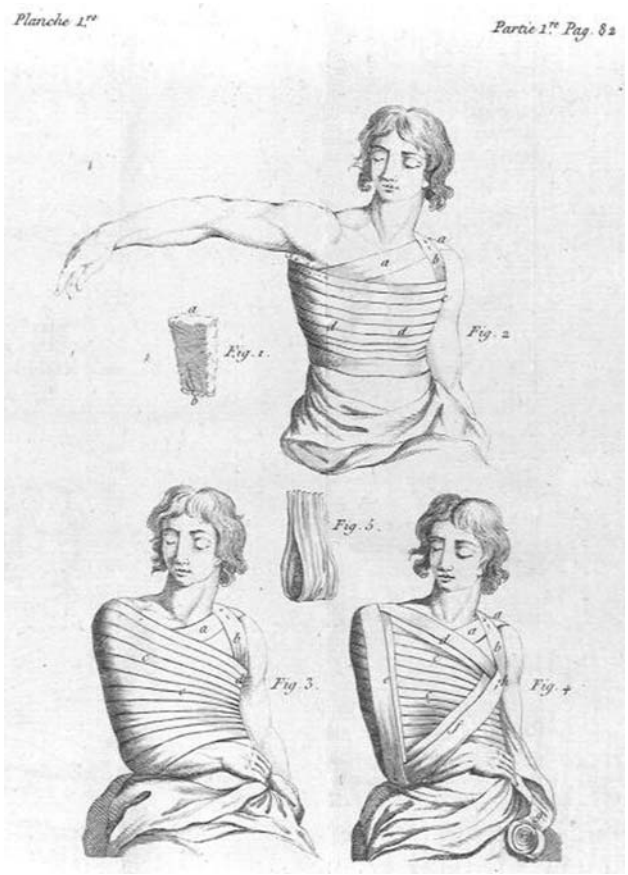


**Fig. 2** Desault's original drawing of his bandage

not only the first illustration of a scapula fracture, but also the first illustration of the floating shoulder.

An excellent description of the clinical examination of scapula fractures may be found in the textbook by a German surgeon Johann Erdwin Christoph Ebermaier (1769–1825) published in 1802 [35].

Dominique Larrey (1766–1842), also a pupil of Desault, and personal surgeon of Napoleon, performed in 1814 an upper limb amputation in a case of open trauma of the proximal part of the limb caused by cannonball. His operating protocol is precisely described by his assistant [13]. There was a comminuted fracture of the proximal humerus associated with fractures of the acromion close to its basis, and of the scapular neck. These two pieces of bone, i.e., the acromion and the coracoid process-glenoid fossa block, were removed during the amputation. The patient healed.

Giovanni Battista Monteggia (1762–1815) in his monumental eight-volume work "*Istituzioni chirurgiche*" [98], published in 1814, distinguished between factures of the body, the acromion and the coracoid process. He also divided them into transverse fractures, fractures of the superior, inferior or lateral angle or fractures of the scapular neck and discussed the possibility of fracture of the glenoid fossa.

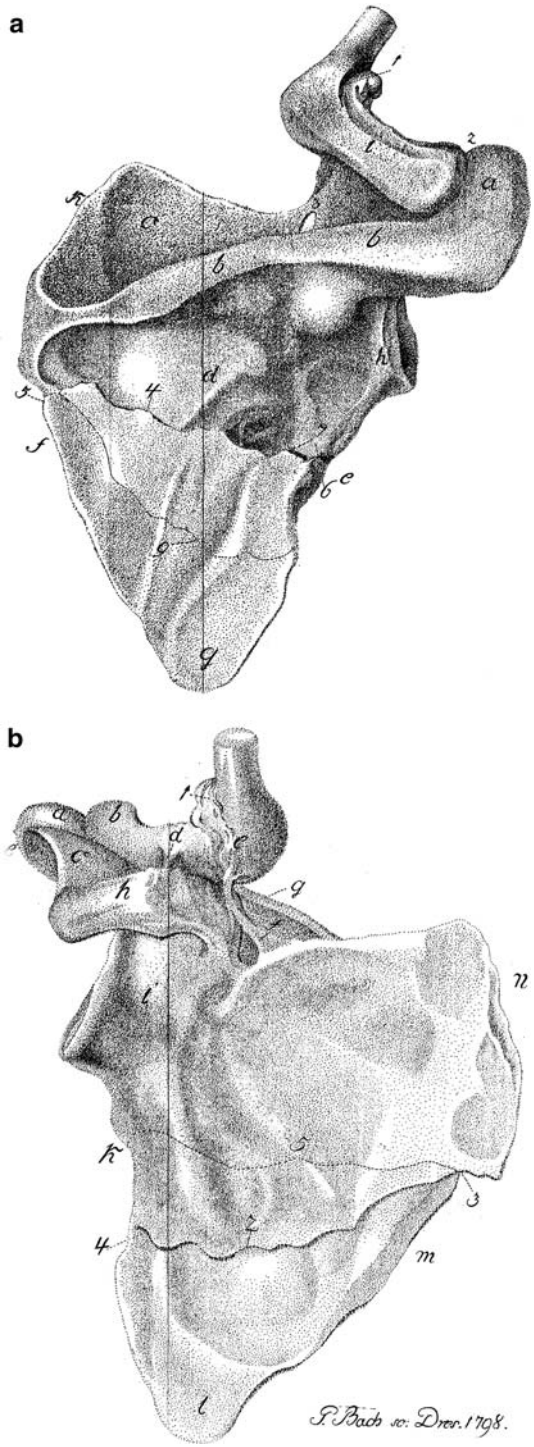


**Fig. 3** The oldest drawing of a scapula (*right*) fracture based on autopsy, published by Vogt in 1799. The illustration shows a simultaneous injury of the clavicle. **a** anterior view, **b** posterior view

Astley Paton Cooper (1768–1841) in "*Treatise on Dislocations and on Fractures of the Joints*" [19], published in 1822, mentioned briefly fracture of the acromion and the surgical neck of the scapula. In its later American edition of

1851 the description of both fractures was supplemented by illustrations [20].

Robert Adams (1791–1875) in the *"Cyclopaedia"* [1], published in 1847–1849, distinguished between three types of scapula fractures—the fractures of acromion, coracoid process, and scapular neck.

In 1847 Joseph Francois Malgaigne (1806–1865) [114] published *"Traité des fractures et des luxations"* [90] accompanied by a number of beautiful lithographs [91]. The chapter dealing with scapula fractures presented a comprehensive summary of the contemporary knowledge. Malgaigne recognized fractures of the body of the scapula, fractures of acromion, fractures of the coracoid process and fractures of the glenoid fossa (Fig. 4).

However, Spence and Steel [129], in 1863, were probably the first authors to present a case of glenoid fossa fracture on the basis of clinical description and autopsy. During autopsy they found avulsion of the distal four-fifths of the articular surface of the glenoid fossa and the fracture line extended as far as half an inch (3.5 cm) below the infraglenoid tuberosity. The tendon of the long head of the biceps with the adjacent portion of the labrum was torn off the upper intact portion of the glenoid fossa. It presented the injury that is known today as SLAP lesion.

The Malgaigne's book that was published in the German translation as early as in 1850 [92] and in the United States in 1860 completed a 50-year period during which scapula fractures were recognized as a special entity. This was

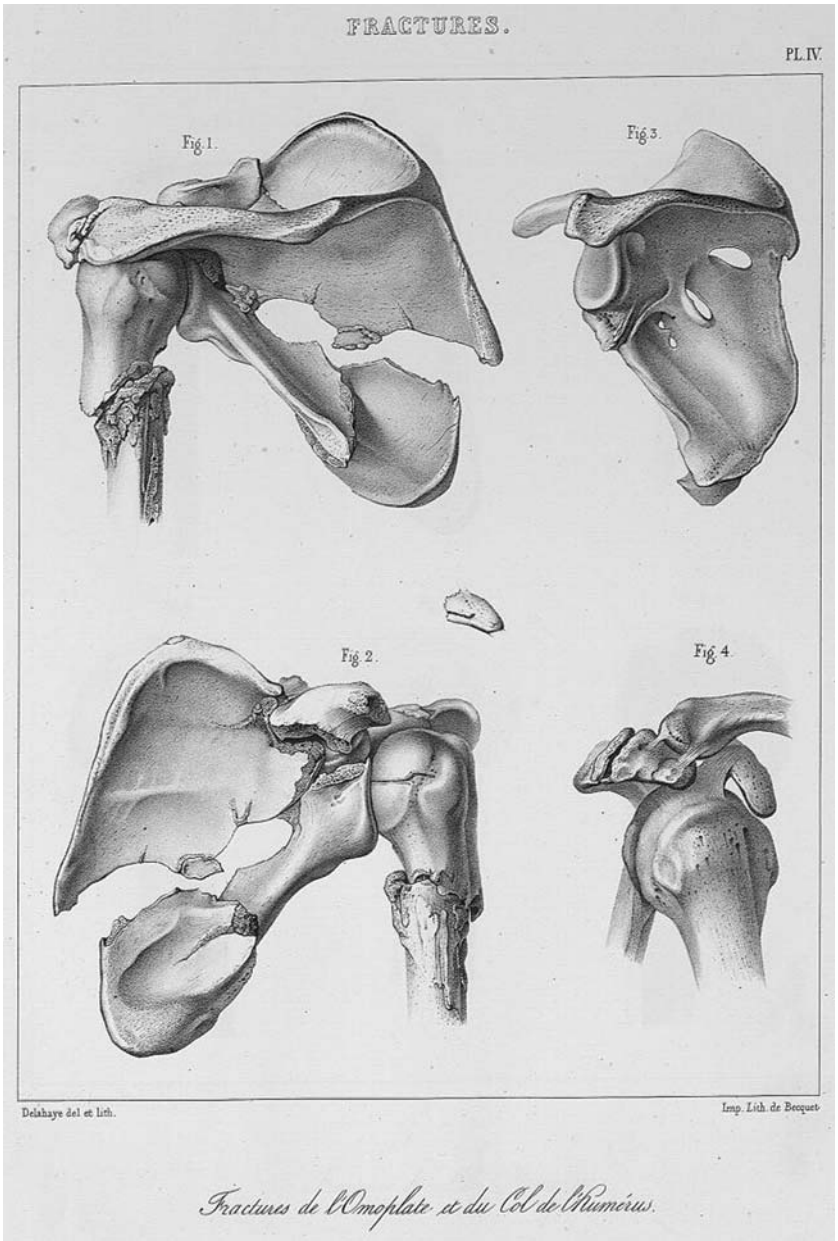


**Fig. 4** Types of scapula fractures—original lithographs published by Malgaigne in 1855

achieved mainly thanks to the publications by Desault, Cooper and Malgaigne, both in Europe and in North America.

In the second half of the nineteenth century there appeared an increased number of publications describing individual types of scapula fractures, with the French authors again predominating [9, 14, 23, 32, 83, 99]. Their articles contain a wide range of very interesting information. Cavayé [59], in 1882, was probably the first to study scapula fractures experimentally.

John Poland (1855–1937) in his monumental work devoted to separation of epiphyses described in detail ossification nuclei of the scapula and apophyseal separation of the acromion and the coracoid [120].

A detailed list of authors of this period and their contributions was presented by Hitzrot and Bolling [64] in 1916.

## Radiological–surgical period (1907–1943)

Discovery of X-rays opened a new chapter in the diagnosis of scapula fractures. Albin Lambotte [77] had probably a radiograph of fractured scapula at his disposal as early as in 1907 although he did not state it expressly in the text. Nevertheless, he canceled the contemplated operation of the displaced fracture of surgical neck due to phlegmon of soft tissues.

According to the literary sources, the first to publish a radiograph of scapula fractures was Cotton [21], in 1910. He presented a radiograph of a fracture of the scapular neck, however, without any further information. Struthers [130] on the other hand, not only published in the same year (1910) a radiograph of a glenoid fracture but also provided a detailed case history.

The first radiological study of scapula fractures included an analysis of 13 cases of different types of the scapula fractures examined between 1909 and 1911 and was published by Grune [53] in 1911. Six radiographs were included. In the same year, only a few months later, Plageman [119] described 19 cases of different types of scapula fractures diagnosed radiologically between 1905 and 1910. However, the text included only three drawings and no radiographs.

The first internal fixation of the scapula was performed by Albin Lambotte as early as in 1910; but he published the case including preoperative and postoperative radiograph as late as in 1913 [78]. It was an unspecified transpinous fracture of the body or neck of the scapula treated with two screws.

Langlet and Herrmann [81] presented in 1911 a case of open fracture of the scapula caused by a lion scratch. The fractured inferior pole of the scapula was extirpated. On this occasion the authors mentioned that they had never used osteosuture suggested by Koenig and Tillemann.

In 1913, Tanton [133] described in detail fractures of the scapular neck. He distinguished between three types of fractures of the lateral angle of the scapula—fractures of the glenoid fossa, fractures of the anatomical neck, and fractures of the surgical neck.

In 1914, William Arbuthnot Lane (1856–1943) performed internal fixation of displaced vertical fracture passing througt the spine and body of the scapula associated with dislocation of ipsilateral acromioclavicular joint [79].

In 1914, Mencke [96] published a study on acromion fractures including the radiographs of different types of this injury. In the same year, Darrach [25] fixed by two silk sutures delayed fracture of acromion, which had healed.

A comprehensive study was published in 1916 by Hitzrot and Bolling [64]. They presented a detailed history of the treatment of scapula fractures in the second half of the nineteenth century, in addition to own eight clinical cases and also results of their experiments.

In 1919, Braine [11] described an open fracture of the scapula associated with epiphyseolysis of the proximal humerus in a 13-year-old boy.

In 1921, Cotton [22] used ether anesthesia in closed reduction of the fracture of surgical neck of the scapula.

In 1923, a French surgeon Lenormant [84] used osteosuture (a wire) of the lateral border for a displaced scapular neck fracture. Three months after the surgery, an infection developed and the hardware had to be removed. In spite of this, the fracture had healed with a good position of fragments. The same year, another French surgeon Dujarier [31] fixed a fracture of the scapular neck by Lane Y-plate. One day later, after him, Basset [4] performed the same surgery.

In the United States, Longabaugh [88] appears to have been the first to treat a scapula fracture operatively in 1924. He fixed the avulsed inferior angle of the scapula using kangaroo tendon. In 1931, Findlay [41] described extirpation of avulsed coracoid process. In 1937, the same author pointed out the correlation between scapula fracture and fracture of ribs [42].

Dupont and Evrard [33] in 1932 fixed a fracture of the lateral border of the scapula by the Sherman plate and presented the first detailed description of the surgical approach along the lateral border of the scapula including two drawings. They were also the first to use the term "pilier de l′omoplate" (pillar of scapula) that has been since then used in the French literature. In the same period (1933), Lorenz Böhler devoted only a few lines to scapula fractures in his textbook [8].

The first internal fixation of a glenoid fracture was described by Reggio [121] in 1938; however, the first pre- and postoperative radiographs of a glenoid fossa fracture were published by Fisher [43] in 1939. His article represented the first publication in the Journal of Bone and Joint

Surgery concerning scapula fractures. In 1943, Harmon and Baker [58] treated a comminuted fracture of the scapula by extirpation of the distal half of the scapula.

During World War II, the next chapter of the history of treatment of scapula fractures was completed. During those 35 years diagnosis of scapula fractures was improved due to radiology; the first internal fixations of individual types of fractures were performed; and surgical approaches described.

## Post-World War II period: the fifties and sixties

The first comprehensive study in the post-war period was published in 1956 by Decoulx et al. [26]. On the basis of their own 26 cases and analysis of primarily the French literature, the French in particular, they divided the scapula fractures into three types—fractures of the body, fractures of the apophyses, and fractures of the superolateral angle. In the first two types they recommended non-operative treatment. In fractures of the superolateral angle, mainly in intra-articular fractures, they advocated operative management, i.e., anatomical reduction and internal fixation. In contrast, Rowe [125], a few years later (1963) supported closed treatment.

In 1964, Acta Orthopedica Belgica published three studies dealing with scapula fractures. Tondeur [135] in his detailed study based on 38 cases used the same classification as Decoulx also recommended internal fixation for displaced fractures of the superolateral angle. Robert Judet [71] advocated internal fixation of displaced fractures of the scapular neck and the lateral border allowing an early restoration of the normal function. He also described an extensile posterior approach that carries his name. In contrast, Jörg Böhler [7] supported non-operative treatment, similarly as his father.

A detailed study based on 87 own cases and a detailed analysis of literature (123 citations) was published in 1967 by Cètre [15]. On the basis of analysis of the results he recommended non-operative treatment for the majority of fractures. The same opinion was shared by de Mourgues et al. [28] who evaluated a group of 130 patients.

## The seventies and eighties and the AO contribution

The "official" approach of AO to the scapula fractures had been developing for quite a long time as may be seen in individual editions of "*Manual of internal fixation*" [100–102]. While the first edition in 1969 mentioned only briefly glenoid fossa fractures, the second edition in 1979 extended surgical indications to fractures of the neck and lateral border of the scapula and included also the Judet approach. The third edition in 1991 specifies scapula fractures in greater detail, although not completely. The same applies to the current "*AO Principles of Fracture Management*" [46].

Among surgeons associated with the AO [45, 63, 69, 74, 89, 98] the first who used the principles of stable internal fixation to the scapula fractures was Magerl [89] in 1974. One year later Izadpanah [69] described in detail the operative treatment of different types of scapula fractures after AO principles. In the same year, i.e., in 1975, Hefte z. Unfallheilkunde N. 126 was devoted to scapula fractures. The most important of them were two articles. The article by Tscherne et al. [136] extended surgical indications, described different posterior approaches and special techniques of internal fixation. The article by Ganz and Noesberger [45] stressed the instability of fractures of the surgical neck caused by ipsilateral acromio-clavicular dislocation or clavicle fracture, i.e., the injury which is today called the floating shoulder.

At the same time, different studies started to emphasize that scapula fractures are in most cases part of multiple injuries resulting from high-energy trauma [68, 82, 95, 134].

Extraordinary contribution to operative treatment was made by Hardegger et al. [56, 57] in 1984. They evaluated a group of 37 patients operated on for a scapula fracture and described different types of fractures of the scapula and principles of its internal fixation.

In the same year, both Gagey et al. [44] and Armstrong and van der Spuy [3] pointed out poor long-term results of non-operative treatment of displaced fractures of the scapular neck. In spite of this, in the seventies and eighties, non-operative treatment prevailing [82, 87, 145]. Internal fixation was indicated only exceptionally, primarily for fractures of glenoid fossa [103]. In 1984, there appeared also the first articles concerning the importance of CT in assessment of scapula fractures [76]. The developing trend towards operative treatment of scapula fractures was indicated in the English literature by a comprehensive review published by Guttentag and Rechtine [55] in 1988.

## The nineties

In the nineties, the interest in scapula fractures significantly increased [5, 36, 49, 50, 54, 72, 75, 80, 85, 106, 107, 126]. The main reason was the growing incidence of these injuries associated with high-energy trauma. Another factor contributing to the growing interest was the CT scan which considerably improved diagnosis of scapula fractures as well as an increasing number of articles documenting poor long-term results of non-operative treatment of displaced extra-articular fractures of the scapula.

A significant milestone was the study by Ada and Miller [2] who in 1991 evaluated 113 patients and found very poor functional results in patients with a displaced scapular neck fracture. They performed internal fixation from the Judet approach in eight patients. They also developed their own classification dividing the scapula fractures into four types—fractures of the processes (acromion, spine, coracoid), neck fractures, glenoid fossa fractures and scapular body fractures. Nordqvist and Peterson [105] published in 1992 long-term results of their 68 patients treated non-operatively for scapula fractures. Fifty percent of their patients with residual scapula deformity had shoulder symptoms. They also set indications for ORIF according to the degree of displacement of fragments.

Attention was focused primarily on glenoid fossa fractures. As early as in 1984, Ideberg [66] published his classification of glenoid cavity fractures that was modified by Goss [47] in 1992. In the same year, Habermeyer [40] published the classification of scapula fractures, also including unstable fractures of the scapular neck. On the basis of analysis of 338 fractures, Ideberg [67] further specified his classification in 1995. Mayo et al. [93] revised Ideberg′s classification in 1998 in terms of surgical approaches in different types of glenoid fossa fractures and recommended anatomical reconstruction.

In 1996, Orthopaedic Trauma Association developed a comprehensive alphanumerical classification system for scapula fractures [109]. This classification was revised in 2007 [110].

In 1992, Hersovici et al. [60] described the floating shoulder, i.e., the ipsilateral clavicle and scapular neck fractures. One year later (1993), Goss [48] defined the so-called superior shoulder suspensory complex. Subsequently, the issue of the unstable shoulder girdle was the focus of a number of other authors [27, 37, 38, 61, 86, 111, 122, 137, 140].

## Beginning of twenty-first century

Scapula fractures continued to the attract attention of specialists at the beginning of the new millennium [6, 10, 12, 16–18, 24, 39, 51, 59, 62, 65, 73, 82, 94, 97, 104, 108, 112, 123, 124, 127, 128, 131, 132, 138, 139, 143, 146]. Recent studies have shown that a high percentage of scapula fractures are associated with other severe injuries, of the chest and head in particular. This fact has an impact on the treatment of these fractures. The number of extra-articular scapula fractures treated operatively is growing [16]. One of the reasons is an improved assessment of scapula fractures by three-dimensional CT imaging [18, 94], as well as studies confirming the impact of malalignment of the scapular neck on long-term clinical outcome.

## Conclusion

History of treatment of scapula fractures is closely connected with the history of the French surgery. Paré, Petit, Du Verney, Desault, and Malgaigne were the first to point out the existence of these fractures. However, the first internal fixation of the scapula was performed in 1910 by a Belgian surgeon Albin Lambotte followed in 1914 by the British surgeon Lane, in 1923 by the French surgeons Lenormant, Dujarier, Basset and later also by Dupont, Evrard and Robert Judet. Based on the French school, the AO/ASIF improved methods of internal fixation of these fractures. Current studies focus on specification of indication criteria of operative treatment of extra-articular fractures of the scapular neck and body that, however, have not been unified, yet.

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