CHAPTER 1

INTRODUCTION
HISTORICAL DEVELOPMENTS

It was generally believed in the eighteenth century that a displacement of the wrist after injury was caused by a dislocation and not by a fracture. The notion that a distal radial fracture was a usual cause of wrist displacement gained popularity in the beginning of the nineteenth century. Autopsies or observations of patients with open fractures showed that a fracture of the distal radius was not rare at all. The famous French surgeon Dupuytren was most explicit in this regard (11). He wrote: “Almost all authors who have written on dislocations of the wrist, have described as many as four kinds; and the only point in which these writers at all differ from each other is respecting the number. ..... I have for a long time publicly thought that fractures of the carpal end of the radius are extremely common; that I had always found these supposed dislocations of the wrist turn out to be fractures; and that, in spite of all which has been said upon the subject, I have never met with or heard of, one single well authenticated and convincing case of the dislocation in question”.

Different types of distal radial fractures were distinguished by physical examination in the nineteenth century, by which in fact the first step in classification was made. Surgeons in several countries like Pouteau in France (21), Colles and Smith in Ireland (5,24), and Barton in the USA (1), described a specific type of distal radial fracture and their names are still connected to particular fractures. It seemed that there was not much controversy about the first choice of treatment and the ultimate functional outcome in those days. Abraham Colles reported that reduction was relatively easy, and good outcomes could usually be obtained after several weeks of immobilisation with specially designed lower arm splints (5). Dupuytren focussed the attention on the importance of early reduction, but also on technical problems to obtain adequate immobilisation (11): “The surgeon should proceed to reduce these fractures (comminuted fractures of the distal radius, Oskam) as soon as possible, and that a misapprehension of the nature of the injury is always attended by impaired use and deformity of the fore-arm”. If the fracture is not adequately immobilized it will dislocate again: “If the tendency of the hand to move towards the radial side of the fore-arm be not counteracted, union will take place
whilst the bones are in this position; and deformity together with impaired power of rotating the fore-arm are the consequences. In some instances the displacement in question is so great, that this bone appears as if curved; and many practitioners have been thus misled into the belief that there was dislocation of its carpal extremity”. To prevent dislocation of the fracture fragments, Dupuytren developed a device in which the hand was kept in an abducted position: “I have, by the above simple method succeeded to my entire satisfaction in curing the troublesome (unstable, Oskam) fractures, without any deformity or sacrifice of the rotatory motions of the fore-arm”.

After the introduction of radiography in 1895 it was soon appreciated that in the majority of wrist injuries the distal radius was fractured. It was also confirmed that malunion after healing of a distal radial fracture occurred more often than was usually thought. Due to radiology, surgeons could assess the quality of reduction, bone healing, and anatomical end results. It appeared that in a large number of patients a normal anatomical relationship was not obtained resulting in a malunion of the distal radius (12). A malunion of the distal radius was characterized by radial shortening, radial deviation, and dorsal angulation as Dupuytren had described earlier without the help of X-rays. Many surgeons thought that instability of the fracture was not the only cause of failure but that technical failure also played an important role (25). So, it was thought that malunion could be prevented in all instances by early adequate reduction and immobilisation.

It was observed in the first decades of the twentieth century by several surgeons that the functional outcome of distal radial fractures was not favourable in patients with malunion. Disturbed anatomical relationships after fracture healing compromise wrist function and may cause pain, loss of wrist motion and diminished grip strength of the hand. Particularly American surgeons became interested to treat anatomical deformations of the wrist, such as a prominent distal ulna due to radial shortening. This classical disorder was treated by resection of the distal ulnar head as was advocated by Darrach (9). Another technique to treat a prominent distal ulna was introduced by Milch. He developed ulnar shortening osteotomy as alternative for ulnar head resection (18). Apart from operations on the ulnar side of the wrist, operations for the malunited distal radius were also
promoted. For instance, Campbell developed radial corrective osteotomy to restore radiocarpal angulation and radial length (4).

It became obvious that primary anatomical reduction could prevent late complications, and might prevent secondary reconstructive operations in many wrists. Nevertheless, most surgeons remained reluctant to perform primary operative fracture treatment. Primary surgery was only considered to be indicated in irreducible fractures, and in these cases open reduction was usually followed by plaster immobilisation (25). Despite the fact that several progressive surgeons developed new operative techniques on the basis of sound clinical observations, these procedures were not generally accepted and, consequently, seldom mentioned in handbooks. Because these books usually reflected the conservative opinions of prestigious surgeons, all attention remained focussed mainly on closed reduction and plaster immobilisation (2,26). So, conservative treatment was undisputedly the treatment of first choice, irrespective of new insights on operative treatment for unstable fractures.

PARADIGM SHIFTS IN TREATMENT OF DISTAL RADIAL FRACTURES

Lambotte (16) and Matti (17) were two representatives of surgeons practising in the first decades of the twentieth century, who advocated open reduction and operative fixation if anatomical reduction could not be obtained by conservative methods. Their aggressive approach was based on the assumption that a strong relation exists between complete restoration of anatomy and wrist function. Lambotte and Matti challenged the leading opinions of conservative treatment protocols for wrist fractures. The interest in operative treatment remained modest despite their efforts. The quality of fixation material was rather poor in the years preceeding World War II, which at the time contributed to rather high rates of infection and redisplacement after operative treatment. This may well have contributed to the lack of succes of efforts to promote operative treatment of distal radial fractures.
It was confirmed by clinical studies published after World War II that the functional outcome after conservative treatment of a fracture of the distal radius was not always favourable. Gartland and Werley showed in 1951 that about 20% of patients complained of wrist pain and showed loss of wrist motion (13). As a consequence, attention was again focussed on the advantages of early restoration of anatomical relations to improve functional outcome. New clinical studies were undertaken in the nineteen-fifties to evaluate the results of osteosynthesis techniques in unstable fractures. Closed reduction and fixation with Kirschner wires became the first paradigm shift. It was the most popular method of operative treatment in the period 1950-1970 (3,8,10,22). The approach of the distal radius was usually not open, because it was assumed that adequate reduction can be obtained by closed means. Open reduction was only indicated for irreducible fractures.

Another paradigm shift in treatment occurred after 1970, largely due to the influences of the “Arbeitsgemeinschaft für Osteosynthesefragen” (AO) (8,19). The AO stressed that the basic principles of joint fracture treatment should be restoration of joint congruency, followed by rigid stabilisation of fractures to enable early practising and functional recovery. With respect to the wrist, restoration of anatomical relationships in the radiocarpal joint was considered to be a prerequisite for good functional recovery. The most appropriate procedure to reach this goal was open reduction and internal fixation (ORIF). To enable osteosynthesis of the distal radius with it’s specific shape, a so called radius T-plate was designed to enable rigid fixation.

Although the advantages of ORIF were theoretically promising it became gradually apparent that ORIF was not suitable for all fracture types (6,12,23). The best indications are presumably fracture-dislocations, like Barton’s fracture, or unstable extra-articular volarly- or dorsally-displaced fractures (7,12). The principles of the AO and the assumed benefits of open reduction and internal fixation do not appear to be valuable for each distal radial fracture type. The most important disadvantages of ORIF are devitalization of fracture fragments and additional trauma to soft tissues which compromise fracture healing and may contribute to the occurrence of infection. Most likely, closed fixation techniques are more
feasible to treat comminuted fractures, because the damage to soft tissues and to the vascularisation of bone fragments is less with a closed technique. Understandably, closed fixation techniques, like external fixation, became popular in the nineteen-eighties and constituted the third, and latest, paradigm shift (14).

**OUTLINE OF THE THESIS**

Quantitative epidemiological factors, like the incidence of wrist fractures or the incidence of particular fracture types, are likely to affect therapeutic decisions and surgical care. So, against the background of optimal clinical care, epidemiological information is an issue. Not only the incidence of distal radial fractures may be an interesting issue, but also aetiological or biological determinants of distal radial fractures are worth to be studied. For instance, the pattern of injury or the age of the patient are factors which eventually determine the fracture pattern in the distal radius. Little is known of epidemiological aspects of distal radial fractures. This lack of knowledge justifies further research because of the possible clinical consequences. Therefore, epidemiological issues are adressed in this thesis.

There is a need for a sound classification system for distal radial fractures. Obviously, a correct diagnosis is required for choosing an appropriate treatment for a particular fracture type. Usually, a historical classification system with synonyms or eponyms is employed to reach this goal. Such historical systems do usually not contain well defined fracture items with the considerable risk that observer agreement is low. A more reliable classification system may be the AO classification system for distal radial fractures. It has been claimed by the AO foundation that this system contains all clinically meaningful fracture types and that it is treatment-based. Since it is important to choose the most appropriate treatment modality for a particular fracture, we have investigated the reliability of a historical classification system and the AO classification system.

Conservative treatment can be performed in about 70 to 80 percent of distal radial fractures (7,12). If operative treatment is required, several technical approaches are available in most instances. There is no doubt that the adequate choice should
be made on the basis of sound evidence, preferably derived from prospective, randomized, controlled studies. In case of distal radial fractures, however, the number of such studies is regretfully low. As explanation may serve the observation that the number of different fracture types of the distal radius is more than thirty, in addition to the fact that each type can be treated with several operative techniques and that many of these fracture types have a very low incidence. Understandably, therefore, published observations as to success or failure of operative treatment of these fractures are mostly restricted to retrospective studies. Since we, too, have focussed on rare types of distal radial fractures, the studies presented in this thesis are retrospective by necessity.

The first concern of this thesis regards the incidence and aetiological patterns of distal radial fractures in the Groningen population. No epidemiological studies of injury patterns have been published in The Netherlands. A unique achievement of the Department of Surgery of the University Hospital Groningen is that a trauma registration system with a database has been maintained since 1970. With that database, epidemiological aspects of a large group of trauma patients such as the incidence of wrist fractures in the Groningen area could be studied. Long term trends of incidence and injury patterns for all trauma patients treated at the University Hospital Groningen are presented in Chapter 2. More detailed incidence rates and injury patterns of patients with wrist fractures are discussed in Chapter 3.

The second concern of this thesis is the reliability of classification of distal radial fractures. Many classification systems have been developed since 1950, but most systems are incomplete since they do not describe all possible types of distal radial fractures (12). A requisite for a proper classification system is that it covers the large number of fracture types which is estimated to be more than thirty, and that it is helpful in choosing an appropriate treatment. Therefore universal, treatment-based classification systems have been designed in the nineteen-eighties. The universal system of the Mayo Clinics was introduced in the United States of America (7), while in Europe the universal system of the AO was propagated (20). The clinical value of these universal classification systems is not
known precisely. Recently, a validation study of the AO system showed that agreement between several observers is not very good (15). It appears that no reliable universal classification system is available to support clinical decision making. This could be the reason why many surgeons still use familiar, historical classification systems to deal with the complexity of distal radial fractures. We have confronted a group of surgical residents with a variety of X-rays with distal radial fractures, in order to decide upon the consistency of traditional classification systems. The results of the study are described in Chapter 4.

Since the concept of a universal treatment-based classification system to support decision making is very attractive, we studied the applicability of the AO/ASIF classification system which is presently used by many in Europe. We determined observer agreement in a series of 124 distal radius fractures which was classified according to the AO/ASIF’s system by two experienced observers. Chapter 5 contains the rates of agreement and a qualitative analysis to causes of disagreement.

Finally, the third concern of this thesis is to assess the value of selected operative techniques which were performed to restore anatomic relationships in particular rare fracture types in order to investigate the postulated association between anatomy and function after healing of a distal radial fracture. In the nineteen-seventies the concepts of the AO movement were also adopted by the trauma surgeons of the surgical department of the University Hospital Groningen, and as a result the treatment of distal radial fractures changed, too. Initially, most primary operations were performed in young patients with complex fracture types or high energetic wrist injuries. An example of such a complex wrist injury is a combination of fractures of the radius and scaphoid. The results of treatment of one of the largest published series is presented in Chapter 6. Another example of a complex, high-energetic wrist injury is dorsal fracture-dislocation of the radiocarpal joint. Although the most appropriate operation technique for this injury has yet not been esthablished, the best treatment is probably open reduction and internal fixation. Because the injury is rare, only small series or case reports have been reported so far. The experiences of the Groningen Department of Surgery
with a series of six patients, and the latest developments in the literature, are presented and discussed in Chapter 7.

An issue in the treatment of distal radial fractures is how to deal with unstable fractures in mentally and physically healthy, elderly patients. The problem with this group of patients is that these patients commonly suffer from secondary osteoporosis. Osteoporosis causes technical difficulties during surgery because the mechanical properties of the distal radius do not allow firm fixation. Fractures in osteoporotic bones are frequently unstable after reduction and heal in malunion causing poor functional outcome. The classical approach in these patients is to start with conservative treatment. The X-rays usually show a satisfactory reduction of the fracture, but during follow up it appears that the fracture redislocates. Currently it is still not clear whether patients with redislocation may benefit from an operation in which wrist anatomy is restored. But if surgery is pursued several technical options may be used, among which closed reduction and Kirschner wire fixation is an attractive option because it is minimally invasive. Our experiences with closed reduction and Kirschner wire fixation after redislocation are presented in Chapter 8.

If a fracture has healed in malunion the anatomic relationship of the radius and ulna can be restored secundarily by a corrective osteotomy. Corrective osteotomies of the wrist have been performed in the Groningen surgical department since nineteen-eighty. Most of these reconstructions took place in young patients because of poor wrist function after conservative treatment. The preferred types of reconstructions were ulnar shortening osteotomy and radial corrective osteotomy. A surgical audit to evaluate the clinical outcome and suggestions to improve surgical techniques are described in Chapters 9 and 10.

REFERENCES

16. Lambotte A. L’intervention operatoire dans les fractures, Lamertin, Bruxelles 1907.
24. Smith RW. A treatise on fractures in the vicinity of joints and on certain forms of accidental and congenital dislocations. Hodges and Smith, Dublin 1847.
