Patient Safety in Orthopedics and Traumatology

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Learning Objective
Surgical specialties have a higher risk of errors and adverse events as represented in literature [1]. Orthopedics is one such specialty in which the clinical risk is more conspicuous and, consequently, it has a high exposure to medical-legal disputes [2, 3]. The aim of this work is to analyze the clinical risk and alleged malpractice in medical practice, in order to map professional risk and identify recurrent pitfalls.

19.1 Introduction

Orthopedics and traumatology are particularly risky specialties for various reasons:

- The very high volume of surgery.
- The reliance on extremely varied skills depending on the nature of treatments (casting and splinting immobilization, open and closed surgery, arthroscopy, etc.), the anatomical sites (hand surgery, shoulder surgery, spine surgery, etc.), and the age of patients (pediatric and geriatric orthopedics), a fact which renders impossible the acquisition of high levels of reliability in all disciplines.
- A progressive increase in surgical indications for traumatic pathologies and/or lesions that, in the past, were generally treated conservatively with casts. Today, patients no longer accept treatments that require long periods of immobilization. The evolution of surgical techniques offers tantalizing alternatives that allow a faster recovery, but involve greater risk related to surgery.
- The ever-increasing complexity of interventions. Within just a few years, orthopedics has grown from a limited number of relatively simple interventions to an enormous range of surgical possibilities, often highly technical (e.g., intraoperative computerized navigation). Where the complexity is high, there is a greater risk of making mistakes.
- Two distinct flavors of specialization: orthopedics and traumatology. The latter is characterized by a clinical path that begins suddenly, due to time-sensitive diagnostic and therapeutic choices conditioned by the time factor, often offering no opportunity for proper planning. The acceleration of any diagnostic-therapeutic procedure generates a greater risk of error, adverse events, or harm.
- The fact that any damage caused produces unavoidable functional repercussions that lead to obvious clinical consequences.

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- The growing attention to repercussions on physical appearance, in addition to those on functioning. Many surgical procedures attempt to correct deformities and any failures cause obvious aesthetic damage.

For these reasons, orthopedics is among the medical specialties most prone to clinical risk, together with oncology, obstetrics/gynecology, and general surgery; "clinical risk" refers to the probability that a patient is a victim of an adverse event and, consequently, suffers any damage that is attributable (even if unintentionally) to medical care.

The damage may consist of a worsening of health conditions, but also of an increase in the duration of treatment and/or higher care expenses. It may be due to an error which in turn can be defined as the failure to complete a planned action, or the adoption of procedures not suitable for the intended purpose; in this case, the damage can be preventable and the underlying error correctable. The damage may also be due to an accident (due to a cause that is independent of a real error) and, consequently, not always preventable; this is an adverse event in the strictest sense.

An error is often the result of various components: human, technological, organizational, procedural, and cultural. Adverse events are difficult to assess, due to their complexity, and require careful investigation in order to implement primary prevention measures, whenever possible. In Sweden, the analysis of adverse events in the orthopedic branch showed that errors in this specific discipline have a high degree of predictability [4]. This type of error deserves the highest dedication of attention and resources.

Of the errors which can be classified through a *Root Cause Analysis* [5], the main types are (1) diagnostic errors, (2) treatment errors, (3) communication errors, (4) evaluation errors, and (5) environmental or system-related problems. In the context of diagnostic errors, further categories can be distinguished, among which the most important are delayed diagnosis, missed diagnosis (unidentified pathology or lesion) or wrong diagnosis (different pathology diagnosis), failure to prescribe diagnostic tests, and incorrect interpretation of diagnostic tests. Treatment errors include treatment delay, incorrect surgical technique, treatment failure, unnecessary treatment, and improper surgical wound care. Communication errors are divided into verbal and written communication mistakes. Evaluation errors include misevaluation of indications for surgery, non-fulfillment of protocols, and inadequate planning. Finally, various organizational aspects are considered with regard to problems inherent to the system, ranging from poor environmental safety to inadequate resources.

19.2 Epidemiology of Adverse Advent

The highest number of clinical negligence claims comes from surgical specialties, orthopedic surgery being the worst offender, responsible for 29.8% of all cases [1]. Casali et al. [6] carried out a retrospective study on orthopedic claims based on an archival data analysis from one of the largest medical malpractice insurance brokers in Italy. Their analysis indicates that orthopedics is the specialty with the highest risk of malpractice claims. Most of the claims studied originated in civil litigation and malpractice was mainly suspected in perioperative and operative cases arising in general hospitals. The anatomical sites most commonly invoked in claims were the hip and the knees (constituting 40% of all claims), and sciatic nerve lesions were the main contributor. Malpractice was ascertained in about half of the analyzed claims, typically cases of elective surgery that resulted in the permanent impairment of a patient. On the other hand, death resulting from orthopedic malpractice was rare.

19.3 Most Frequent Errors

In orthopedics, risk is mainly related to two types of procedures: diagnostic and therapeutic [6–8]. Therefore, subsequent discussion will be concentrated on these two types. However, it is necessary to remember that a strict classification of risk is not possible, since the categories of adverse

events are numerous and since a causal chain can combine various causes from within each category. For example, the most classic typology in the category of treatment errors, that of surgery performed on the wrong limb, often sees a communication error as the main causal element.

Hospitals are the main sites of error in orthopedics and traumatology. In the patient's clinical route, there are three main phases: intake, hospitalization, and discharge. Intake usually happens through an outpatient appointment, an emergency room visit, or a transfer from another department. Patient intake is the phase in which diagnostic errors mainly occur. These errors have a high incidence in orthopedics and traumatology, comparable to that of therapeutic errors [9], even though diagnostic errors have been the subject of fewer studies. Although the causes of diagnostic error are numerous, the main mistakes are the insufficient collection of anamnestic data and clinical examination results, a failure to check previous health records (laboratory tests, reports of previous hospital admissions, etc.), insufficient knowledge of diseases compatible with the clinical presentation, a failure to generate diagnostic hypotheses or the formulation of incorrect diagnostic hypotheses (a differential diagnosis focused on the most striking or the most recently encountered diseases rather than the most statistically probable hypothesis), a lack of consideration of diseases or associated therapies that modify the diagnostic approach, a lack of time or an overload of work, the lack of knowledge or a failure to assess the accuracy limits of tests, among others.

Intake from the emergency department runs a higher risk of error than intake from an outpatient clinic. The importance of a diagnostic error during an intake from the emergency department is very variable. It can be relatively negligible, such as the failure to highlight a fracture of a distal phalanx of a finger, or it can have devastating consequences, such as neurological damage caused by a vertebral fracture that goes unrecognized and, consequently, not adequately immobilized. A lack of an initial diagnosis most often delays the start of therapy, possibly leading to a worse outcome or a more difficult treatment; furthermore, in all cases of delayed injury identification, the prolongation of pain until a definitive diagnosis represents a significant source of discomfort. Finally, even if the physical consequences are minimal, there is always the concern of psychological stress trauma, deterioration of the doctor-patient relationship, or a loss of confidence in doctors or the hospital.

Traumatologic emergency care has been described as "the perfect storm" for a traumatologist (or radiologist) [10, 11], as the following conditions can occur simultaneously: an unstable patient, a difficulty to collect a complete anamnesis, a need to make important decisions quickly, a confluence of different specialist skills, a need for different treatments at once, overcrowding, and working with young or trainee health staff.

The polytrauma patient has the highest concentration of risk factors. In these circumstances, some orthopedic lesions often go initially unnoticed, both because of the need to focus clinical and instrumental diagnostics on conditions that endanger the patient's life and because of the multiplicity of lesions, some of which distract from fractures that are more difficult to identify through clinical examination (such as vertebral fractures). The initial evaluation is not always reliable; for example, it may happen that attention is initially drawn to more striking injuries that actually have lower priority: a severe facial trauma evokes a visceral response but, if the airways are clear, rarely constitutes a serious threat to the patient's life, while it can divert attention away from an unstable cervical spinal cord lesion of critical importance.

The most frequently misunderstood lesions are fractures, followed far behind by ligament injuries, dislocations, and tendon injuries. Vascular-nerve lesions are even less frequent but they are of high importance due to the risk of irreversible damage. The need for an accurate neurovascular evaluation of the limbs of the trauma-orthopedic patient is certainly well-recognized, but often overlooked: an interesting study published in 2012 in the American Journal of Medical Quality [12] highlights the existence of a statistically significant association between the increased experience of the examiner and the

reduced or inadequate documentation of the neurovascular status of extremities.

A fracture may go unrecognized for many reasons; the following main groups can be distinguished: the absence of targeted instrumental examinations, the failure to observe the fracture even with a targeted instrumental examination, the incorrect interpretation of an examination, and the effective absence of radiographic evidence.

The failure to prescribe a radiographic exam is the second most frequent cause of diagnostic error, preceded only by the failure to observe a fracture in correctly performed radiographs [13]. Prescription error can be caused by various factors. First, it must be recognized that, however simple it may be to perform a targeted X-ray examination on a conscious patient who can pinpoint the origin of pain to the site of a fracture, the examination becomes extremely challenging when performed on a patient who is unconscious or in an altered sensory state. Furthermore, even in lucid patients, pain may not always be present; this may be especially true for elderly patients, in whom the frequent occurrence of bone fragility may cause the severity of trauma to be underestimated.

Failure to observe the fracture even through a targeted instrumental examination occurs relatively frequently in some anatomical regions that do not appear in standard projections. For example, fractures in the lower cervical/upper thoracic spine are often invisible due to the overlapping of the shoulders in a lateral projection; therefore, if the clinical presentation or the dynamics of the accident cannot exclude the presence of such lesions, an in-depth diagnostic analysis with CT is necessary.

The misinterpretation of the results of a correctly performed exam is primarily due to error in diagnostic imaging [13], while the actual absence of radiological signs, even in the presence of a lesion (a true false negative), is a rare but possible event (Fig. 19.1). These errors are mainly relevant to the radiological specialty, for which reference should be made to the respective literature [14, 15].

The most frequent locations of unrecognized fractures are hand, wrist, and foot and ankle; each anatomical site has a characteristically prevalent type of unrecognized lesion, posing very different degrees of danger: in the wrist, the most frequently unrecognized fracture occurs at the distal end of the radius (more so than all greenstick

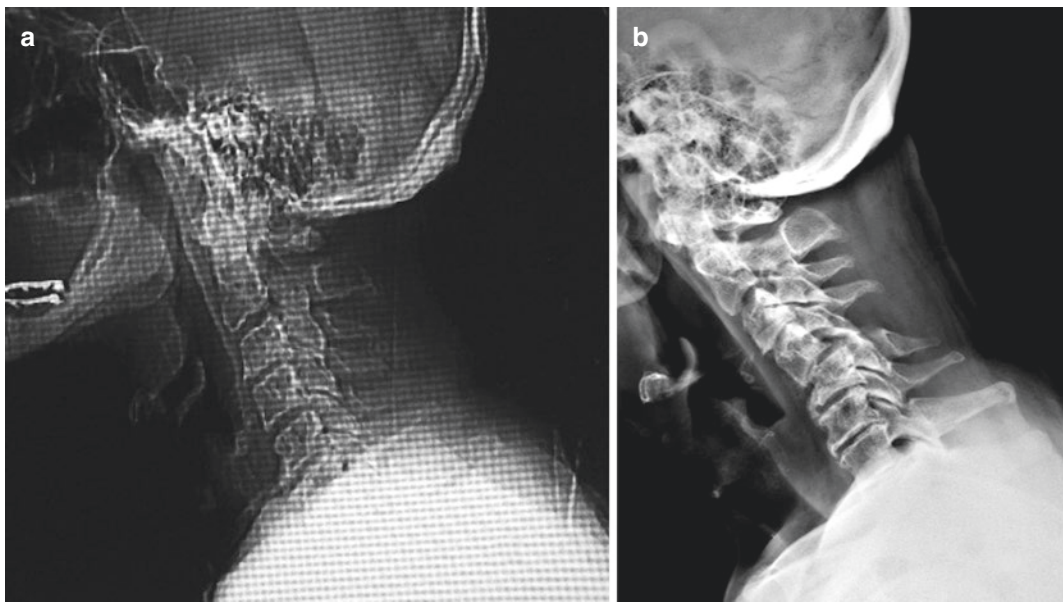

Fig. 19.1 (**a**) CT scan normal, performed on the day of the accident; (**b**) cervical radiograph performed 2 months later demonstrating C4–C5 subluxation

fractures in growing subjects); however, the scaphoid fracture, often completely invisible in initial radiograms, is the most important for its clinical consequences. In the elbow, fractures of the radial head are the most often ignored; in the hip, fractures of the branches are the least identified lesions, even though the consequences are definitely more serious in the less frequently undetected fractures of the femur neck. In the knee, the diagnosis of intercondylar eminence fracture is not frequently made, but the rarest joint fractures of the tibial plateau produce the most serious consequences. At the level of the ankle and foot, fractures of the external malleolus and calcaneal apophyses are those that most often escape the initial diagnosis, but more care must be taken when excluding thalamic calcaneal fractures, fractures of the talar neck, and the rarer fracture-dislocation of Lisfranc, which are determining factors in the severity of aftereffects when not promptly treated.

Regarding the spine, most of the missed diagnoses entail substantial risks: at the cervical level, fractures of the atlas and axis (and in particular of the odontoid process) can cause serious if not fatal neurological damage or pseudoarthrosis. At the level of the thoracic spine, compression fractures of the first vertebrae are frequently overlooked, since, as with lower cervical vertebrae, they are not visible on standard radiographs. The most frequently underestimated fractures are those of the thoracolumbar passage in elderly subjects or those with bone fragility. Even though these vertebrae are often the site of compression fractures (as well as low-energy trauma), the area is not sufficiently investigated either because the trauma is considered an insufficient cause for concern, or because the examination is incorrectly centered around the lumbosacral rachis (the site of radiating pain).

On the other hand, diagnostic errors may also be contrary to those previously described. They may consist of an unindicated radiographic examination or a radiographic diagnosis of fracture where it is absent (i.e., radiographic false positives, for overlapping artifacts or anatomical variants). In the former case, this leads to potentially damaging ionizing radiation exposure and, in the latter case, to the unnecessary prescription of treatments (usually orthosis). The percentage of radiographic false positives in the radiology of the skeletal system in an emergency department can even reach 18% of cases if the radiologist has not yet gained sufficient competence [16].

Not all diagnostic errors result in therapeutic errors. Even if in orthopedic traumatology small fractures may go unnoticed relatively frequently and consequently be misdiagnosed as bruises or distortions, treatment (e.g., immobilization, rest, or weight-bearing restrictions) is often compatible with a favorable final result.

Hospitalization in the orthopedic-traumatological ward occurs by various means and, given the nature of the specialty, the purpose of hospitalization is typically surgery. Considering that surgical errors are the most frequent among the therapeutic errors, studies in literature have focused more on these than on others. In a work published in the Archives of Surgery of 2009 [17], all incorrect surgical and/or invasive procedures due to errors made in or outside the operating room were analyzed; data collected from the Veterans Health Administration (VHA) Medical Centers from 2001 to 2006 were analyzed and it was found that about 50% of the adverse events had occurred in operating rooms, and the rest outside. Orthopedic surgery was ranked among the first places for adverse events occurring in the operating room, while interventional radiology set the record for errors outside the surgical theater. Across the board, the most common cause of error was a lack of communication.

Incorrect surgical and/or invasive procedures represent a challenge both in and out of the operating room. Surgical errors can be classified in the following main groups: patient identification, surgical technique, and postoperative surgical complications.

Patient identification errors can be further subdivided into three subgroups: wrong patient, wrong anatomical site, and wrong procedure [18, 19]. Anatomical site errors have two peculiar characteristics that make them particularly of note in the context of clinical risk management: the first is that the consequences are particularly serious in terms of damage to the patient; the

second is the high level of preventability, which renders viable their complete elimination and transformation into never events.

This type of error is not so rare: it has been calculated that the risk of making an anatomical site error within 35 years of an orthopedist's professional career is about 25%, particularly in arthroscopies for side errors and in vertebral surgery for level errors [20].

Anatomical site errors can be prevented by implementing various types of procedures: (1) preoperative checks, with clinical/instrumental exams and the use of specific items of the preoperative checklist. The identification of the patient, the side to be operated on, and the type of intervention should always take place in all phases, starting from the addition to the waiting list to the admittance into the operating room, always actively involving the patient, if their state of consciousness and the level of vigilance has not been compromised by concomitant pathologies; (2) marking the site with ink resistant to aseptic procedures. The mark must be visible even after the preparation of the sterile field. If it is possible to make an error even when the side is correct (for example, in the case of the various fingers of the hand), the mark must be specifically located on the anatomical part to be operated on, possibly precisely tracing the incision. In any case, the mark must not be ambiguous: it must be made by the first operator and known to the whole team; furthermore, there must be no other marks on the body. In spinal surgery, the use of specific radiological techniques may be necessary in order to identify the cutaneous region corresponding with the surgical level or the single vertebra; (3) "time-out," the last check performed by team members immediately before the surgical incision. Each activity must be suspended for a moment and the correctness of the site must be checked once again, verifying that the marked site agrees with the checklist.

Despite the implementation of protocols, reports of site errors are constantly increasing [2], probably in part thanks to improved transparency. Consequently, the risk of making mistakes in this sector is not negligible, above all because site errors tend to be underestimated by the orthopedist who, often due to an excess of confidence, does not consider it as a possibility.

Surgical technique errors are extremely variable and a detailed discussion is outside the scope of this chapter. Spinal surgery is the most frequently involved [21] (e.g., neurological damage) together with prosthetic hip and knee surgery [22, 23] (e.g., mobilization of prosthetic components). Infectious complications, which were included in the next group, also weigh heavily in this context.

Most failures in orthopedic surgery are related to postoperative surgical complications, often arising from a failure to take adequate preventative measures. In traumatic and orthopedic pathology, surgical complications can be classified as local or general. The main local complications are related to infections, which occur in surgery at a constantly increasing rate despite improvements in aseptic procedures. This increase is probably due to the continuous evolution of implants and osteosynthesis systems, which require increasingly complex and prolonged interventions, on top of fears of new, resistant bacterial strains. The risk of infection cannot be completely eliminated; nevertheless, it is essential to reduce the risk as much as possible through the most accurate execution of each sanitary procedure according to the rules of asepsis, both in the ward before and after surgery, and in the operating room during the surgical phase. The key to preventing infections is sterility in the operating room and the management of surgical wounds in the ward.

General complications are extremely variable but thromboembolism is the most widely involved in orthopedic risk management. Antithromboembolic (ATE) prophylaxis and therapy, when needed, are a highly debated and controversial topic. There are various guidelines drawn up by the leading experts in the field, which are continuously reviewed and updated. The assessment of a patient's overall thromboembolic risk is tailored to the various departments in which this complication is more prevalent (with orthopedics at the top of the list). Adequate antithromboembolic prophylaxis must always be established while taking into account its counter-

part: the risk of bleeding. In the context of general complications in orthopedic departments, the mortality rate is widely used as a safety indicator. Panesar et al. [24] analyzed deaths in the orthopedic environment using a qualitative approach to identify causative factors: the conclusions were that most deaths were due to avoidable or treatable complications.

Even patient discharge is a critical moment along the clinical route. It is essential to give the patient clear and detailed information highlighting all the possible risks (e.g., risks relating to an incorrectly performed thromboembolic prophylaxis or antibiotic therapy).

The medication reconciliation and handover [25] represent crucial moments for the care of a patient at home and for communication between the hospital doctor and the general practitioner. Communication in the discharge phase is very important; it must be certain that all information is understood by the patient and that they are invited to re-read the prescriptions of drugs or repeat the recommendations made.

Furthermore, it is appropriate to consider the socio-cultural background and the personality of the patient, in order to be sure that the indications are well understood and do not cause problems for their family.

During the discharge phase, checklists are useful to remind the doctor of all the necessary checks to be made before discharging the patient, including the removal of any devices and reporting to the general practitioner in particularly complex cases.

19.4 Safety Practices and Implementation Strategy

In absolute terms, the number of orthopedic patients suffering preventable adverse events is high. Critical phases of the clinical route are usually divided into tasks by organization, technology, and professional skill. Diagnosis errors are mainly linked to a lack of professional skill and organizational problems. In the case of professional skill, the specific training of health personnel must be improved. Various therapeutic protocols cover the most important steps in cases of polytrauma, especially those needed to rule out vertebral lesions. Providing information about the most easily misunderstood injuries, especially potentially serious ones, draws and maintains a high level of attention towards specific anatomical sites. For example, in the case of wrist trauma, tenderness of the snuffbox could indicate a possible compound fracture despite the absence of clear lesions of the scaphoid upon radiographic examination; it may therefore be appropriate to immobilize the wrist along with the first finger and re-evaluate the patient clinically and radiographically after a period of 7–10 days, when a possible compound fracture would be more evident after the initial bone resorption. In the case of cervical whiplash, there are specific protocols that determine if a radiographic examination is required. Finally, a fracture of the thoracolumbar passage in an osteoporotic subject with low back pain will not go unnoticed if guidelines are provided for acute low back pain and the epidemiology of fractures, such as the recommendations that patients over the age of 55 receive radiographic control of the spine and that X-ray control must be extended to the L1–T12 vertebrae which are the most frequent fracture sites.

With regard to organizational problems, individual phases of the diagnostic-therapeutic path must be distinguished. In urgent care and in emergency facilities, it is essential to regulate the access to prevent overcrowding.

In the orthopedics and traumatology departments, the main critical points are patient and surgical site identification, proper ward management including the compilation of the medical record and therapy, peripheral vascular-nervous status assessment, prevention of venous thromboembolism and infections, control of pre- and postoperative bleeding, and correct indications in the postoperative period as well as at discharge. Some of these problems are common to every other department while others are more specific. An inadequately completed medical record, besides representing a serious danger for the patient, is also an act of negligence. Without a

precise clinical diary, it will be difficult, or even impossible, to clearly reconstruct the diagnostic-therapeutic course of that patient, which is essential to understand the context of an adverse event if one should occur.

The main critical tasks for the prevention of surgical error are also organizational and professional. From an organizational point of view, the surgical checklist is the most fundamental tool; it must be concise, complete, intuitive, and easily understandable to all the personnel involved, both in the operating theater and in the ward. A checklist is useless if its compilation, involving each actor, is not complete across every sector and within the pre-established timetable. Subsequent contributions by a single operator are useless and harmful. Consequently, efforts must be directed towards two main areas to ensure the quality of care and of future investigations: those in which the error has a higher incidence rate (e.g., communication, instrumentation), and those in which the error, even if less frequent, represents a serious risk for the patient (e.g., management of drugs/medications, surgical site errors) [2].

Taking into account the professional criticalities, it is possible to limit surgical technique errors by improving the training of personnel, even in simulated settings. It is desirable, especially in large hospitals, to promote super-specialized disciplines through the creation of subsets of surgeons dedicated to specific sectors, such as hand and spine surgery.

Most complications in orthopedics and traumatology can be treated or prevented thanks to the knowledge and the implementation of strategies for clinical risk management. It is more correct to say "risk management" than "risk elimination," because risk cannot be realistically eliminated. Risk is an ever-present condition and our aim must be the identification, understanding, management, and finally reduction of adverse events. The main purpose of clinical risk management is primary prevention, which includes continuous updating and professional training, aimed at improving health care; in addition, communication skills and the prevention of surgical errors must be improved, with the help of protocols and checklists already widely distributed and available.

We must learn from our mistakes. Hence the importance of clinical audits and Mortality and Morbidity meetings. Adverse events and errors must be contextualized; the risks and criticalities present in context must be identified in order to introduce control and prevention measures. This is possible when there is adequate communication, consultation, control, and review of cases and, above all, when a health organization believes in safety management.

A modern approach to clinical risk management is represented by the *Failure Mode and Effects Criticality Analysis* (FMECA), a technique that allows to identify defects or errors of the system in a simulated way. Data relating to this interesting procedure, also tested in orthopedic departments [6], are still preliminary but definitely useful in the context of clinical risk management.

19.5 Clinical Cases

19.5.1 Case 1

A 68-year-old man was injured in a car accident. The first treatment was performed in a local hospital. The physical examination revealed a head injury and cervical pain. The cranial CT scan was normal. The lateral X-ray cervical view was normal until the level C6. The injury mechanism involved high energy and a cervical CT scan was performed. The cervical CT scan was also normal (Fig. 19.1). Two months later, the patient visited due to a persistence of the cervical pain. The clinical examination revealed pain and a deficiency in the range of cervical spine motion, without neurological impairment. No radiologic examination was ordered and the patient was prescribed analgesics and physiotherapy. After a month, the persistence of pain led to a second assessment: a cervical radiograph was ordered and demonstrated C4–C5 subluxation. There are only a few cases of neglected cervical spine dis-

locations reported in the literature and no clear guidelines regarding the management of such injuries. Therefore the treatment of delayed presentations of such cases is very difficult and the patient now needs a risky and complex surgical intervention. The diagnosis of cervical spine injuries remains a significant problem for many blunt trauma patients. Correct and early diagnosis of these injuries is imperative, as delayed or missed diagnoses result in increased morbidity and mortality.

The first error of diagnosis was radiologic: the sensitivity of the CT scan to cervical trauma is 98% but may fail to identify ligamentous injuries. Only an MRI can detect this type of lesion before the subluxation.

This case report underscores the importance of integrating all aspects of patient history, precise physical examination, diagnostic imaging, and clinical judgment. Re-evaluation is necessary when the CT scan does not correlate with physical examination. The diligent integration of both physical examination and the review of images obtained will undoubtedly lead to a decrease in claims of medical malpractice.

19.5.2 Case 2

The patient is a 16-year-old girl with no known family history of neurofibromatosis. She had noticed some deformity in her spine when she was 8 years old, and was diagnosed with neurofibromatosis type I (NF-1) and followed up by a neurologist. She had a scoliotic deformity of the spine, more pronounced during a forward Adam's test. During the neurologist's initial follow-up, serial plain radiographs that had been performed every 2 years revealed progression of the scoliosis. Then, 5 years ago, when she was 11 years old, the patient was treated with a brace. However, the curve rapidly progressed as she entered the adolescent growth spurt, with scoliosis measuring 50° Cobb, kyphosis 56°, and Risser 1 (Fig. 19.2). Even so, the brace treatment was continued. When the patient presented herself at our hospital, she was Risser 5 and the radiological imaging showed a classic dystrophic kyphoscoliosis with Cobb angles measuring 88° scoliosis (T5–T8) and 85° kyphosis (T2–T101) (Fig. 19.3).

Neurofibromatosis is an autosomal, dominant chromosomal disorder and scoliosis is the most common skeletal presentation, with incidence ranging from 10% to 60%. Our patient had a kyphoscoliotic curve of the proximal thoracic spine, with severe apical rotation from T5 to T8. The clinical presentation and radiological imaging in this patient were very suggestive of dystrophic features and included: (a) short segment and acute angular deformity; (b) early occurrence at the young age of 8 years old; (c) sagittal plane kyphoscoliosis; (c) pencilling of the ribs; and (d) defective pedicles. Early surgical stabilization was indicated in this patient at an early age of onset because of the risk of substantial progression of the curve. However, the doctor had opted for nonsurgical treatment in the initial stages, using a brace: this is an error of treatment and it was not surprising that bracing had failed nor that the curve had rapidly progressed. Now the patient needs multiple, complex, and risky surgical interventions.

19.6 Recommendations

To conclude, two important elements must be mentioned in orthopedic risk management. The first is that the biggest danger comes not from the risk itself but from ignorance, as many orthopedists do not fully appreciate the level of risk and so do not feel the need for more scrutiny.

The second is that a good doctor-patient relationship is as essential as both professional competence and compliance with protocols and guidelines. When approaching clinical practice, the principles of classical medicine, from the Hippocratic oath onwards, must always be kept in mind. According to Nebel [26], the best prevention against both adverse events and their legal implications can be summed up by the ancient precept "*love thy patient*."

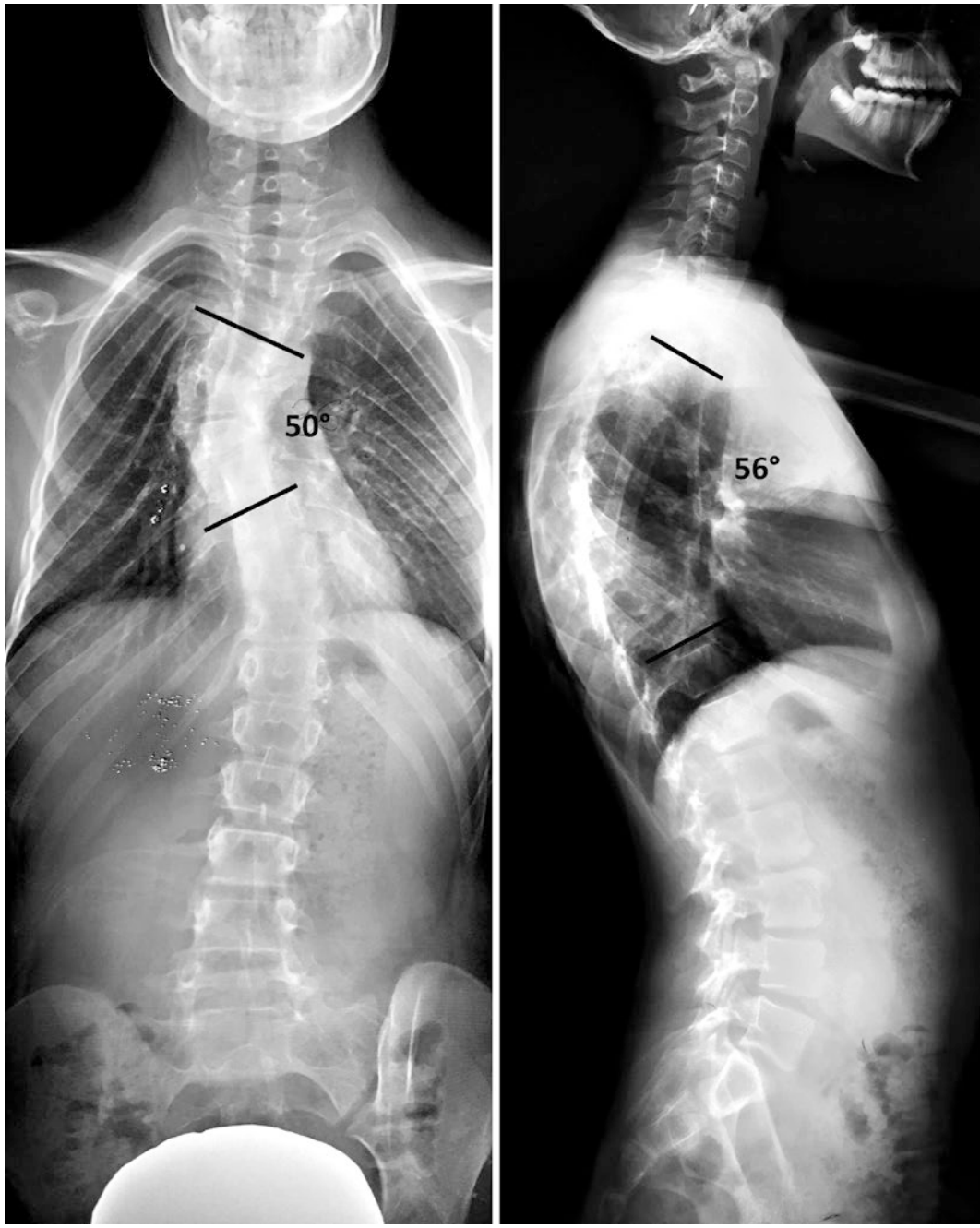

Fig. 19.2 Standing whole spine radiographs in NF1 patient 12 years old, showing sharp angular right-sided kyphoscoliosis: dystrophic curves have always surgical indication and the conservative treatment is contraindicated

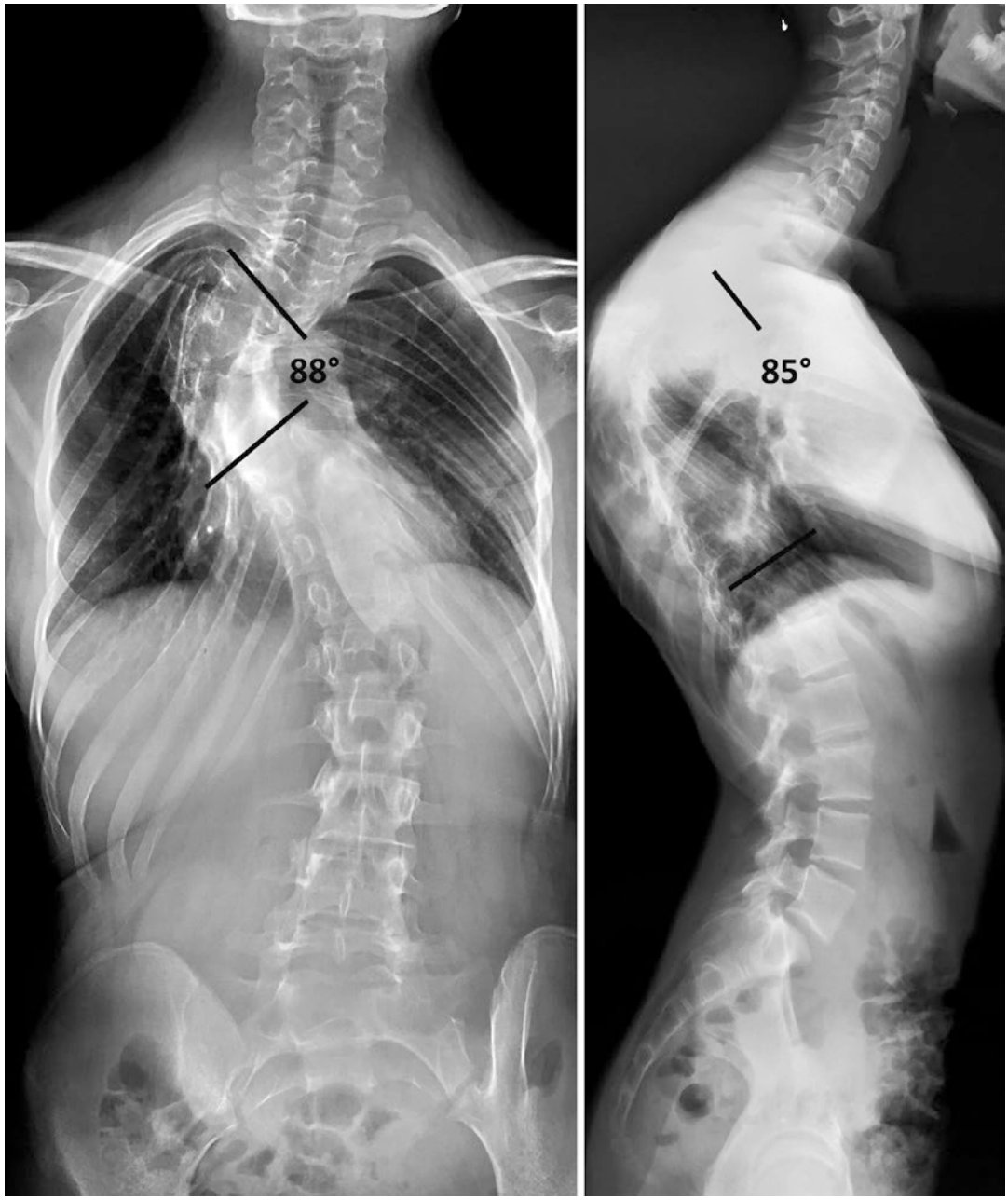

Fig. 19.3 Same case of Fig. 19.2 after 4 years of conservative treatment with progression of the scoliotic and the kyphotic curve

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