We agree with the views expressed by the illustrious speaker Mr. Denis who claimed that osteosynthesis is a necessary procedure in the face of the failure of conservative or non-surgical treatment. Now, there are no hard-and-fast criteria that tell us what we should understand by a failure or an insufficiency. What for some is an adequate result, for others is unacceptable because it causes anatomical or functional abnormalities, it frequently leads to sequelae, stiffness or atrophy, it requires a long recovery period, etc.

Nonetheless, in our opinion the field of osteosynthesis is becoming larger and larger as surgeons feel more confident regarding the safety of the technical solutions it proposes and the benignity of its operative procedures. As they compare the results they achieve with the different techniques they employ, surgeons have become increasingly critical of their work and nowadays tend to reject procedures that in the past they considered satisfactory.

As far as the pathology and treatment of fractures is concerned, not all cases are alike. We know that many fractures can be kept perfectly reduced throughout the osteoinTEGRATION period, which tends to be fairly short. However, in other cases either reduction is difficult to maintain and there is a risk of secondary displacement or integration takes such a long time that it inevitably leads to atrophy and stiffness. Lastly, there are other cases in which not even an intermediate degree of reduction and coaptation can be achieved with non-surgical procedures. Osteosynthesis is especially useful in the last two cases, i.e. either to obtain reduction and containment that would be impossible with any other technique or to secure an active degree of early mobility that protects the limb from undesirable sequelae. If we had to define the current status of osteosynthesis, we should say that it is going through a renaissance, both in terms of the techniques and principles used.

We unquestionably recognize the essential role played by the modern proponents of osteosynthesis, especially Sir Arboutnot Lane and Albin Lambotte, and would not like to be taken to belittle them if we said that they established a number of principles of osteosynthesis and developed a number of rules that, naturally, could not be the true principles or the final techniques since, even today after so many years, both the techniques and principles of internal fixation are in permanent evolution and improvement.

The use of flawed principles and inappropriate materials that often acted as aggressive chemical agents interfering with the integration process, as well as the nonbalance and ineptitude displayed by surgeons on some occasions led to a series of disasters and, consequently, to a campaign against osteosynthesis and to the fear of applying internal fixation techniques that most of us have all experienced.

However, only the list of the terrible sequelae of osteosynthesis – normally the result of a poor technique and ignorance about the procedure – was generally presented. The equally terrible sequelae provoked by conservative or closed techniques, even when well applied, tended to be ignored. Not enough emphasis was placed on the inability of the latter to address the problems inherent in a large number of cases either.

The undeniable truth is that osteosynthesis has outlived all the criticism leveled against it and has overcome its crisis; that is the reason why we said that it was going through a renaissance. Modern fixation materials, the way in which they are used depending on the type of fracture and anatomical region at issue, as well as a better knowledge of bone biology and the evolution of the integration process and the bone reactions of the various anchor points have all worked the miracle. The onslaught of prejudice that threatened with demolishing osteosynthesis eventually disappeared.

As a result of the recent developments, surgical techniques have improved and it is no longer thought that a single general method or technique can be applied to all cases; on the contrary, the most suitable mechanical solutions are being developed for each anatomical region and for each fracture type within them, always in line with the general biological characteristics, with those specific to each particular and with the function of the involved skeletal segment.

As regards osteosynthesis, we must emphasize as energetically as possible that success and prognosis are based upon the ability of harmonizing two types of principles that although not incompatible can sometimes prove difficult to bring together:

1.) Mechanical principles, derived from the shape of the fracture and its fragments, from its texture (either cortical or cancellous) and the muscular and gravitational forces acting upon them; and 2.) Biological principles derived from the bone’s vitality, its nutritional paths, the reactions of the integration bone tissue and the anchor points for bone attachment.
fixation. This harmony should result in the achievement of a bone callus that gathers all the fragments into a single whole leading to no ensuing anatomical or functional sequelae, with the recovery process taking a minimum period of time.

Osteosynthesis could therefore be described as «a surgical procedure intended to keep two bone fragments together with correct alignment and through a direct or intra-site system with the aim of getting them fused through a bone callus.» Apart from considering the purpose of the procedure, this definition encompasses, together with a correct alignment, the reduction and coaptation of the fracture during the integration process; i.e. the restoration of bone continuity by means of autologous material.

The reason for this need lies in the fact that fixation at the bone’s anchor points (either cortical or cancellous), however firm it may seem, always involves the use of extraneous materials subjected to stress patterns that are dissimilar to the normal mechanism of skeletal parts. In addition, the strength of the bone structure is not constant but is rather connected to the bone mineral (sodium salts) density, which diminishes as a result of the osteolytic processes that accompany the first few phases of osteogenicity. If an overload occurs during the evolution of osteointegration and the magnitude of the resulting static and dynamic forces exceeds that of the strength of the anchor points (measured in square millimeters) fixation will fail totally or partially if the process of fracture healing is still not advanced enough as to absorb at least part of the stress.

These considerations are important, on the one hand, for the mechanics and biology of the anchor points vis-à-vis the system and surgical technique used and, on the other, for the moment and degree of function that can be allowed in the course of the healing process in order to prevent the risk of overload.

Lastly, when integration has been achieved, the fixation system and the anchor points cease to act as elements endowed with a mechanical function and become inactive. For this reason, whenever possible, one should use fixation systems that can be easily extracted; although the fact that the current stainless materials are well tolerated by the bone slightly undermines the importance of this principle.

A classical principle in osteosynthesis is that the fracture site must remain unmoved. In our previous work, we conveyed this idea in geometrical terms by stating «in order to be efficient, any osteosynthesis system considered in abstractum, whatever its shape or nature, should constitute an intermediate system or piece between two fragments that is capable of acting upon each of them by establishing a connection between them, controlling the three planes of space in as balanced a way as possible and exerting minimal stress upon the anchor points.»

This principle should be supplemented by an additional notion, namely that which says that the vitality of these anchor points ought to keep its mechanical ability until integration has been achieved.

To summarize, we would like to present the following principles or conclusions:

1. There is not – and could not be – a general osteosynthesis procedure that is better than others but rather each fracture type, within the anatomical region it is in, should be addressed according to its mechanical and biological characteristics.

2. Opening a fracture site need not make the surgeon more wary than necessary; of course asepsis and the avoidance of frivolous, unnecessary or ill-advised operations are of the essence.

3. Osteosynthesis techniques cannot be improvised. Before starting surgery, it is vital to make sure that any potential difficulties and adverse events – however unlikely -have been anticipated.

4. Fixation devices only have a temporary function and are not meant to permanently substitute osteointegration; indeed our final goal is bone healing so, whenever possible, osteosynthesis devices should be implanted in such a way that they can be easily extracted when they are no longer needed.

5. An attempt should be made to harmonize the immobility of the fracture site with the mobility of the limb in order to minimize the sequelae and shorten the time of inactivity; but this must be done in the right proportion so that the magnitude of the static and dynamic loads does not exceed that of the strength of the anchor points, which would lead to the failure of the fixation system and therefore to pseudoarthrosis.

6. Any system that speeds up the restoration of bone continuity, transferring the typically abnormal mechanical action of the anchor points to the bone structure, will make an invaluable contribution to the success of osteosynthesis.
Commentary

This article is the transcription of a presentation made at the XIIIth International Congress on Surgery by Mr. Hernández-Ros, pioneer of Spanish Orthopedic and Trauma Surgery. Although evidently many years have gone and the knowledge of and indications for osteosynthesis have developed, many of the comments made by Mr. Hernández-Ros are still current. Of course osteosynthesis is not indicated just in cases where non-surgical treatment has failed, but the article anticipated the new paths that osteosynthesis would in fact follow. The paper discusses the two principles of osteosynthesis that are still valid: achieving a degree of reduction and containment that cannot be secured otherwise and allowing early movement. On the other hand, Mr. Hernández-Ros seems to be favorable to – and even keen on – the use of this technique stating that on the basis of mechanical and biological principles it is enjoying a renaissance.

In the author’s view, the role of osteosynthesis is to protect rather than replace osteointegration’s physiological process; i.e. it improves the condition of the fracture so as to promote the integration process, transferring any deleterious mechanical stress to the synthetic materials. But the paper not only deals with the advantages of the technique; it also mentions its limitations and the problems posed by osteosynthesis when, in the early stages, mechanical stresses are transferred to an osteosynthesis still incapable of withstanding them.

Although there are still a few unknowns, we already possess a fair amount of knowledge about the physiological process that lies behind osteointegration. Today we know that the biology of fracture repair is really based on a regenerative tissular process rather than a healing process. The injured part is replaced by bone and not by scar tissue, which nonetheless does happen in the lesions occurring in other organs and systems. Currently we know at least two types of integration: secondary (comprising four phases: inflammation, soft callus, hard callus and remodeling) and primary, where there is no hard callus and which is obtained by completely immobilizing the fracture site. In the chondral bone formation, the new bone is formed onto a cartilaginous layer and the emergence of external or periosteal callus can be observed. In secondary integration this type of callus is not formed; a direct Haversian transformation takes place.

For this type of integration to occur, three requirements must be met: precise reduction, stable fixation and sufficient blood supply. The interfragmentary distension resulting from the movement between the fragments determines the type of tissue formed at the site. When there is mechanical stability and the fragments are in close contact, little cartilage is formed together with a thin layer of hard callus through Haversian remodeling. When the patient’s mechanical condition is unstable, the hard callus is not capable of forming a bridge between the fragments early enough, which leads to the appearance of an exuberant cartilaginous callus and later on, if there is enough stability, endochondral ossification will ensue. If we do not include these simple notions into our daily practice we may place the future of our fractures at risk and mistakenly relieve that, for example, the administration of bone growth factors can bring about healing in a fracture site characterized by pathological mobility and avascular margins.

In sum, when Mr. Hernández-Ros wrote this article osteosynthesis was at the beginning of a path that would eventually lead it to the place it occupies today among the essential techniques in the field of orthopedics. The concepts of dynamization, locking, neutralization or compression plates, cortical or cancellous screws, etc had not yet reached the realm of trauma surgery. In those days techniques were still craftsmanlike and probable subject to few rules, materials primitive and not very compatible and the principles that osteosynthesis would develop largely unknown.

But there is no doubt that many of the comments made by Mr Hernández-Ros have laid the foundations for osteosynthesis as we know it today, which combines the concepts of stability with minimally invasive surgery. I am sure that most readers will endorse the six conclusions at the end of the paper, even if they formulated several tens of years ago, and that the demanding conditions that Mr Hernández-Ros laid down for his technique are at present as valid as ever.

D. Hernández-Vaquero
School of Medicine. University of Oviedo. Spain.