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Tissue-sparing surgery (T.S.S.) in hip and knee arthroplasty

Editorial

TISSUE-SPARING SURGERY is a "surgical philosophy" referring to a maximum respect for tissues and, therefore, for anatomy and biomechanics. The aims of tissue-sparing surgery are *to reduce local and general surgical "aggression"*, and thereby to *optimize the patient's postoperative course and functional recovery*. It is not a particular surgical technique like, for example, minimally invasive surgery, but simply an improvement of traditional surgery, from which it has derived over the past decades in light of the previously mentioned aims. In fact, tissue-sparing surgery regards all surgical fields and therefore also orthopedics, where it finds expression in arthroscopy, minimal invasiveness, computer-assisted surgery (especially in traumatology) and, finally, the design of "*mini-prostheses*" for arthroplasty.

In this editorial, I discuss tissue-sparing prosthetic surgery of the hip and knee, extrapolating from the general context to identify a field that I would like to call "tissue-sparing surgery for hip and knee arthroplasty". *The rationale and main features of this field may be summarized as follows:*

1. The prosthesis integrates into the joint and does not substitute it.
2. There is maximum respect for anatomy.
3. There is maximum restoration of joint biomechanics.
4. The surgical access routes are chosen with respect to the SOFT TISSUES and BONES. Surgical incision of the skin, a soft tissue, is minimized as much as possible while still permitting the intervention and the correct implant of the prosthesis. The surgery is performed in full respect not only of blood vessels and nerves but also of the musculotendinous apparatus and the capsuloligamentous system.
5. Blood loss is minimized.
6. MINI-PROSTHESES are used to maximize the conservation of bone stock, yet at the same time to guarantee primary stability and adhesion as well as the distribution of bone stress along physiological lines; this optimizes implant integration and bone remodeling in the successive bone-prosthesis interaction. Use of mini-prostheses permits implantation through small surgical access routes and facilitates conservation of soft tissues.
7. DEDICATED INSTRUMENTS are used.
8. COMPUTER-ASSISTED applications such as image analysis and virtual interventions are used.

9. The bone-prosthesis interaction is promoted by the application of growth factors (REGENERATIVE MEDICINE).
10. *Only diseased tissue is removed while healthy tissue is spared* (i.e. tissue-sparing surgery).

Over the past 20 years, this surgical strategy has been adopted by numerous orthopedic surgeons who have modified their activities. They have abandoned old ways of thinking, expressed by the saying “large cut, large surgeon”, coined in the first part of the 1900s when aggressive surgery was justified by the necessity to be fast and by the limited anesthesiological techniques.

The “traditional” access routes and prostheses have now been reinterpreted in the spirit of reducing surgical trauma and blood loss and improving results. Surgical complications have become less frequent and the time for recovery and rehabilitation has been reduced.

The most important phenomenon nonetheless is the preference for a few CONSERVATIVE PROSTHESES or MINI-PROSTHESES, among all the traditional ones, and especially the development of new, innovative prostheses that preserve bone stock and restore joint biomechanics. This is true for both hip and knee.

Regarding the hip, I refer to femoral head resurfacing prostheses, to neck-preserving prostheses, to prostheses that conserve the spongy metaphysis and to cups for preserving acetabular bone. These prostheses, to a greater or lesser extent, also improve skeletal stress, and therefore they promote remodeling and prosthesis lifetime. Finally, they facilitate the re-establishment of geometric parameters such as offset, indispensable not only for obtaining good joint function but also for reducing forces at the head-cup junction and, consequentially, wear and formation of debris (compared to traditional prostheses made of the same materials and with the same head and cup diameters).

Regarding the knee, the use of monocompartmental prostheses, especially those that require only minimal bone removal, represent a fundamental moment for tissue-sparing surgery. These have led, almost automatically, to the use of small, conservative access routes. Even more than in the hip, monocompartmental knee prostheses require careful insertion into the complex biomechanic and kinematic situation of the knee, especially when bi-monocompartmental prostheses are used. In this case, the tissue-sparing principal that the prosthesis does not substitute the joint but integrates with it is ever so true. In fact, when implanting a monocompartmental prosthesis, it is wrong to correct the joint biomechanics that caused the pathology; instead, one simply substitutes the part that degenerated due to the disease. Today, other solutions have been proposed and are being validated, such as spacers and the hemicup.

In the past years, COMPUTER-ASSISTED surgery has demonstrated great promise, both for hip and knee, especially concerning the use of navigators. *This so-called robotic surgery can be distinguished into two main types:* active and passive. Active robotic surgery indicates that, during the intervention, the robot actively carries out certain steps; this method permits preimplant bone preparation with extreme exactness and reproducibility, and offers the chance to plan the intervention and choose the prosthesis with great precision through prior execution of a “virtual operation” at the work station. The virtual operation requires a complete set of diagnostic images, usually obtained with spiral computed tomography (CT), with reference points placed on the patient during a small, preparatory operation. The elevated costs and organizational complexity of active robotic surgery, as well as other difficulties, have resulted in a temporary interruption of the use of robots in prosthetic surgery. At the Orthopedics Clinic of Genoa University, between 2000 and 2002, I personally implanted 18 hip prostheses using the Caspar Robot. Although I have not published the results of these activities, on the basis of patients' feedback the outcomes were excellent. Moreover, there were no major intra- or postoperative complications, nor revisions. The difficulties encountered, the costs and, finally, the failure of Caspar put an end to this activity.

The situation for navigators is different. Several case series with medium-term outcomes have been published, especially for the knee. These papers reported better realignment of the joint axes for prostheses implanted with the aid of the navigator, especially the imaging-free type.

Independently of the need to acquire experience and to clinically validate computer-assisted surgery, today one can affirm that this approach will bring notable advantages to tissue-sparing surgery, for example it will permit the surgeon to check the position of the prosthesis when the access route provides only reduced vision during a minimally invasive procedure. Optimization of the implant is mandatory and prevalent, regardless of the surgical technique used. The use of access routes that may be enlarged at any moment of the operation is also advantageous.

In tissue-sparing surgery, *mini-prostheses* have by now a consolidated role in prosthetic surgery of hip and knee, especially regarding femoral neck conservation which, together with acetabular bone conservation, has been used clinically for about 25 years, as have monocompartmental knee prostheses. Examples of hip mini-prostheses are the Collum Femoris Preserving (CFP) stem and the Trabeculae Oriented Pattern (TOP) acetabular cup (Waldemar Link, Hamburg, Germany). Clinical validation studies have shown both the positive aspects and limitations of these mini-prostheses. For example, the cephalic resurfacing prosthesis first was characterized as having tribologic limitations, but later was shown to improve outcomes in young and active patients.

One can affirm, on the basis of this brief review, that tissue-sparing surgery is capable of obtaining its desired scopes. Short-term results have demonstrated that the intra-operative respect of tissues results in less blood loss and reduced surgical trauma, thereby facilitating the postoperative course and reducing hospitalization time; functional recovery is also improved and accelerated. Long-term results are not yet available for any prostheses a technique above-mentioned to determine if the functional outcomes obtained with tissue-sparing surgery are better than those obtained with other techniques, but nonetheless this approach offers the possibility of re-implantation in particular the CFP. This is shown in long-term results. Indeed the principles of femoral neck-conserving prosthetic surgery, and the results accumulated over 25 years, testify to the advantages of this technique.