Knee arthroplasty today

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With the change of style of life, increase of activity level and mean age of population we have in the last decade contributed to an impressive improvement in procedures of Total Knee Replacement (TKR) and today this is the most expanding arthroplasty procedure, with an increasing number, twice that for Hip replacement; in The U.S from 1997 to 2004 the number of implants has grown by 83 % in patients from 45 to 64 years of age.

Since my first introduction to TKR during a short fellowship with John Insall at the Hospital for Special Surgery in 1984 the procedure itself has gone through dramatic changes both in surgical technique and in design and mechanics of the components, but despite its enormous success it remains among the most debated and controversial topics between dedicated surgeons and there are many issues, with pros and cons that are constantly investigated.

Firm answers are still far from being identified and each surgeon supports his theory and researchers continue to put all their efforts into understanding the most appropriate solution.

Distinct to the hip the knee joint has much higher biomechanical implications and difficulties to be reproduced in a prosthetic component and many efforts have been spent in trying to understand the real knee kinematics.

Previous designs were based on the assumption that the distal femur has a constantly changing centre of rotation but more modern *in vivo* kinematics studies have demonstrated a much more complex movement requiring an equally complex design [1].

The understanding of such complex motion has permitted greater surgical flexibility in various OA condition (varus, valgus, stiff, rheumatoid, post traumatic) thanks to sophisticated design solutions mimicking very closely the physiological knee kinematics.

Improved implant design and kinematic pattern have shown to be capable, in the long term, of better clinical and functional outcomes [2].

Kinematics can not underestimate the importance of accurate ligament balancing and navigation may represent an useful tool in achieving a more physiological control of the femoral roll back in flexion preventing any instability from ligament unbalancing during knee flexion [3].

Navigation, as many newly introduced technologies, has yet not proved to be of advantage in TKR; many authors report a more accurate implant position because of greater accuracy of bone cuts orientation that, in addition to a better gap balancing both in flexion and extension, improves not only implant outcomes in a long time frame but also overall patient satisfaction. Others take an opposing view and report a non statistically significant difference in advantages in implant alignment denying possible reported differences in functional outcomes or “subjective best knee” when computer assisted procedure is performed [4].

Never-the-less navigation despite its unproved benefits and outcomes improvement is recognized to be time consuming

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and technically demanding with related complications and this has stimulated further investigation on alternative procedures in order to improve implant positioning relative to each patient and their individual morphology and deformity.

Patient specific instruments have been introduced in practice aiming for shorter surgical time and reconstruction of mechanical axis calculated pre-operatively on MRI imaging and customization of the implant to the patient's deformity.

Interesting findings are reported in the paper of Conteduca [5] confirming the non unanimous experience with this technology and concluding that PSI are less accurate than CAS in positioning components, particularly in the sagittal plane, and recommend the procedure be performed by experienced surgeons who can verify accuracy of bone resection before and after any further step.

Erroneous bone cuts beside determining inappropriate biomechanics may damage ligaments insertions; PCL represents a fundamental of knee kinematics and its insufficiency must be appropriately considered for its proprioceptive function, more correct kinematics and stabilisation of the knee in extension whether an insufficient PCL in a cruciate retaining (CR) implant is reported to be associated with persisting pain, giving way of the knee and poor clinical performances and outcomes.

It appears then to be fundamental to estimate prior to surgery the location of PCL tibial footprint to evaluate possible ligament damage following the suggested cut; referring to the fibula head [6] as an anatomical landmark is reported to be constantly reliable giving the surgeons the possibility to decide whether to use a non cruciate retaining implant.

TKR is intended for treatment of degenerative OA generally associated with axial deformity, generally varus, and less frequently valgus, this being related to rheumatic diseases, post traumatic condition or iatrogenic, following excessive corrective osteotomy, and with a failure rate directly correlated to severity of pre-operative deviation.

Bone remodelling and ligament contraction and elongation, require different surgical approaches and corrections, planning in advance the amount of constraint of the implant [7], tricks and tips from experienced surgeons on all these aspects are therefore always welcome in order to achieve long lasting results in these demanding procedures.

Stiffness is equally challenging and flexion contraction must be separated from flexion limitation when facing the possible solution and the understanding of different anatomical structures involved allows the surgeon to follow appropriate steps adapting surgical strategies to each patient, obtaining full extension and ROM and anticipating possible complications, so frequent in a valgus knee, particularly when flexion limitation is present [8].

Frequently modification of the original tibial slope is suggested as a possible solution to increase flexion in TKR but

Kastner [9] in his ten year analysis contradicts such theory and states that alteration of tibial slope does not influence nor increase ROM and it should not be altered during surgery.

As for any other implant the biggest controversy in TKR remains implant fixation to the host bone, especially in young active patients: cement or no cement will be the ever unsolved dilemma.

Osteolysis associated with cemented implants have raised questions about the longevity of the implant and cementless TKA have been developed as attempt to improve its survival.

Kim in an unique study design [10] showed at 17 years no significant differences amongst the type of fixation stating that signs of Osteolysis detected in well integrated implants have made clear that loosening of the implant is strictly correlated to P.E wear debris rather than failure of cement fixation and in a long time frame results show no evidence or proof of superiority of cementless over cemented TKA.

Neither has the use of Hydroxyapatite been reported to determine superior results in cementless implant at 15 to 22 years of follow up: for sure “not a magic powder” [11] but a useful adjunctive in achieving a sound cementless bondage with the host bone.

Patellar resurfacing is responsible for active divergences and intense debate for the numerous possible complications: dislocation, fracture, necrosis, component wear and loosening, overstuffing and rupture of the component, all these have brought the procedure of resurfacing the patella to be the second cause of revision; on the other hand retaining the native patella can limit such complications but often is associated with residual persisting knee, pain diffuse or anterior that is not improved by a secondary replacement. At this stage meta-analysis is unable to prove real additional advantages in resurfacing the patella [12].

The last decision is surgeon dependent and based upon accurate evaluation of all different value : thickness, height, patellar tendon mobility, changes in the articular cartilage, performance of the procedure with accuracy and precision to avoid risks of further complications.

Malfunctioning patellar femoral joints, despite resurfacing, are responsible for severe and limiting pain due to increased stability, increased joint pressure or altered muscular lever arm [13] and identification of the exact problem may give the potential to solve the problem.

Whenever a patient is a candidate for a TKR procedure only on occasions, especially in women, I am not concerned with metal hypersensitivity and its consequences: as a matter of fact this condition has become particularly relevant among the population due to social and environmental reasons and affects 10 % of population with persisting pain, swelling, necrosis and radiolucent lines with lymphocytic response being the most common problem.

Innocenti [14] gives an excellent understanding on how to diagnose and treat patients with such a condition reporting encouraging results when an appropriate diagnostic protocol is applied and an appropriate allergic implant is positioned, and Kretzner [15] remind us that hypersensitivity may start from the positioned implant releasing metal ions from wear of the substrate determining local response and thus, similarly to P.E debris, to loosening of the implant.

Blood loss is a major issue in TKA with a need of transfusion reported in percentage ranging from 9 % to 84 % and many attempts have been suggested to limit perioperative blood loss and associated transfusion [16].

Autologous donation was found not to be justified and economically feasible because of the large number of discharged units [16] and of interest is the multimodal approach proposed by Gomez Barrena [17]; the use of a tourniquet reduces blood loss but increases postoperative discomfort related to soft tissue damage due to the pressure applied and its more limited use does not increase blood loss [18]. In post operative management non continuous wound drainage has shown significant reduction of blood loss and no increase of postoperative complications [19].

In TKR patient's satisfaction is the main parameter for considering a successful procedure and often patient's and surgeon's expectations are dissimilar and most of the adopted scores are controversial on measured activities. Of certain interest is the proposed patient based outcome score [20] from Sasaki indicating that conventional objective scales report only disturbances of TKA during daily living activity and that a more open questionnaire is needed to obtain correct information on overall implant behaviour.

Patient's satisfaction is strictly correlated to implant function and long term survival and Kim [21] demonstrated in his cohort of patients in a long term follow up that correct implant position plays a major role in assuring such goal and observed that implant position in an overall anatomic alignment in the coronal, sagittal and rotational plane has provided 99 % survival at 15.8 years of follow up.

Subjective satisfaction starts in the post operative time and containment of surgical consequences such of local oedema, wound hematoma and post operative inflammatory process is fundamental in achieving this. Two different studies have investigated and proved efficacy both of biological and biophysics treatment to enhance post operative recovery.

Aggarwal [22] introduced in his surgical procedure platelet enriched plasma showing not only a significantly reduced blood loss but also a reduced pain and correlated use of medication in the immediate post operative period with an easier pain free recovery of ROM.

Of certain interest is the application of pulsatile electromagnetic stimulation [23] in the post operative with reported improvement of pain and swelling in the immediate post

operative period but more interestingly with a significant reduction of the number of patients complaining of continuous discomfort of the knee in the three years time frame.

Despite rigorous antibiotic prophylaxis protocols infection remains the most important cause of failure and removal of the implant is an elective type of treatment followed by an interval implant and re-operation when the infective process has been controlled; as an interval implant today there is consensus on articulated antibiotic loaded spacers. Castelli [24] refers to an excellent maintenance of ligament tension, function and ROM during the interval period allowing an easier recovery and high percentage of infection eradication after the second operation.

Occasionally every treatment for infection fails and any attempt to save the implant must be left in order to perform a salvage procedure due to severe soft tissue and bone conditions.

In this case arthrodesis remains the treatment of choice, but beside loss of function patients complain of the associated significant shortening of the leg for the need of bone to bone fusion.

In order to avoid such consequences an interesting and viable option is the suggested use of an intramedullary cementless nail [25] that does not require bone contact with the residual gap filled with antibiotic loaded cement providing a 89.5 % complete infection regression in a two year follow up.

Aside from infection bone loss must be faced in every implant failure and this should be managed depending upon amount of bone to be restored. Different classifications allow surgeons to perform adequate pre-operative planning and then choose the most appropriate reconstructive procedure: augments, sleeves, massive cancellous bone grafts must be case sensitive and their use based on surgeon skills and experience in order to assure optimal integration of the implant to the host bone [26].

When reconstruction is performed particular attention should be taken to achieve a sound rotational stability of components in order to guarantee through an optimal bony integration longest survival of the implant.

Because of complexity, cost and time consumption of the revision procedure, prevention of failure of this becomes a primary issue and identification and understanding of pre-operative condition affecting a favourable outcome and survival of the implant become fundamental.

General and local condition such as age, rheumatoid disorders, septic loosening should then be addressed adequately [27].

Anatomically the knee joint is characterised by independent compartments that can be affected separately and thus treated separately: this is the case with the patello-femoral joint that has been investigated for prosthetic replacement and the recent increased interest has brought a new generation of components but as for other implants long term results

represent a reference bench mark to proceed with further development.

It's clear that because of its functional relevance the patello-femoral joint is sometimes the main cause of persisting and limiting symptoms leading to a TKR but in these cases isolated arthroplasty of this joint represent an excellent and proven efficient alternative [28] and excellent long term results support its use when indication is correct and the operative technique is appropriate.

Similarly, for medial and lateral single compartment issues, unicondilar arthroplasty is a proven successful procedure and because of fast recovery and easier post operative management is continuously increasing in numbers; more over pressure from hospital administration on length of stay and cost this procedure is becoming an outpatient procedure.

This appears to be feasible and safe [29] but only in dedicated centres and based on experienced and validated multidisciplinary protocols.

The lateral compartment is affected by isolated degenerative processes less frequently and corresponding arthroplasty requires higher surgical skills, being a more demanding procedure : correct indication, accurate planning and surgical technique must be followed in order to achieve satisfactory results.

Ollivier and Argenson [30] present an excellent hand out to an easy understanding of this less frequent operation with very encouraging outcomes.

Also in UKR component position and alignment, despite localization, are crucial for reconstruction of mechanical and anatomical axis and long term survival of the implant and because unicondilar arthroplasty is reported to be a more demanding procedure, particularly for correct components placement, use of a dedicated navigation software for [31] has resulted in significantly limiting poor results and related complication, with reduced length of surgery and hospital stay.

As Guest Editor I have learned a great deal from reading all the selected papers, submitted or invited, for this Special Issue, which demonstrate the continuous interest of many to share their experience with others and I hope it will be the same for all the readers from all around the world to whom this volume is dedicated.

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