X-ref ***For other Roundups in this issue that cross-reference with Knee see: Trauma Roundup 7; Oncology Roundup 6; Children's orthopaedics Roundup 1; Research Roundups 4 and 6.***

Unicondylar knee arthroplasty: how does it work?

Unicondylar knee arthroplasty (UKA) was first conceived in the 1970s and has become an increasingly popular and relatively successful operation as a result of improved implant design, instrumentation, and surgical technique. Five-year survival rates have been reported with a range between 87.5% and 93.1% among the large national joint registries, however, patient selection still remains one of the biggest potential obstacles to the overall success of the procedure. Investigators in **Berlin (Germany)** have reported one of the most important studies on UKA to date, with data from 20 946 UKAs performed in 19 719 patients in Germany between 2006 and 2012 through a large German healthcare insurance database (Allgemeine Ortskrankenkasse), with the aim of identifying patient factors associated with the success (or otherwise) of the procedure.[1] Using anonymised data from this insurance database, the five-year survival of UKAs was analysed, and survival estimates using Kaplan-Meier survival curves were then used in combination with multivariate Cox regression models. The overall survivorship in this series of UKAs at five years was in line with previous survival data at 87.5%, but on the lower end of previously reported survival data. Most revisions were performed within the first two years post-operatively and it appeared that the one-year revision rates decreased every year from 2006 to 2012, likely due to increasing surgeon experience. Survivorship curves and regression models indicate that significant risk factors for early revision surgery included female sex, younger age, complicated diabetes, depression, low hospital surgical volume (0 to 40 cases per year) and obesity ($\geqslant$ 30 kg/m^2). However, five-year survival did not appear to be dependent on the primary arthritis diagnosis or the presence of other systemic comorbidities, aside from diabetes. Allgemeine Ortskrankenkasse insures nearly 30% of the German population, and is one of the largest healthcare providers in the country, however, it should be remembered that this dataset may not be entirely representative of the country at large. Regardless of this limitation, there is evidence here that modifiable risk factors such as mental state (depression), BMI, and diabetes status should be optimised prior to UKA, or one should use caution in offering a unicondylar arthroplasty in this patient population.

Implant design and knee crepitus

Patellar crepitus following posterior-stabilised (PS) total knee arthroplasty (TKA) is a complication that is relatively common and is in all likelihood caused by a fibrosynovial proliferation on the posterior aspect of the distal quadriceps tendon. This in turn gets "caught" in the intercondylar box during flexion. The characteristic popping, crackling, or snapping of the patella associated with this problem has been reported in between 0% and 13% of patients. Implant design certainly has a role to play in the avoidance of this complication and, in particular, the femoral and patellofemoral components have been identified as factors often associated with patellar crepitus. In an attempt to reduce the occurrence of this phenomenon, manufacturers have moved towards a reduced ratio between the intercondylar box height and the anteroposterior femoral component height, and a decrease in the thickness and width of the trochlear flange. Authors from **Denver, Colorado (USA)** evaluated the incidence of patellar crepitus between two PS TKA designs: the PFC Sigma (Depuy Inc., Warsaw, Indiana) and the Attune (Depuy Inc.).[2] The former is a historic device with a known incidence of patellar crepitus, and the latter, a modern device incorporating design changes in an attempt to reduce this problem. This is a retrospectively designed study reporting the outcomes of 1165 patients with the PFC Sigma TKA system and 728 patients with the Attune TKA design, with a minimum of one-year follow-up. No differences in age or pre-operative range of motion were found between groups. At six weeks, three months, one year, and two years post-operatively, radiographic and clinical evaluations were performed. Patellar crepitus was identified by examination during flexion, and then patients were asked if they were aware of any symptoms. Patients with the PFC Sigma TKA had a higher incidence of surgeon-identified crepitus, patient-identified crepitus, and crepitus requiring operative intervention compared with patients with the Attune TKA, at one- and two-year follow-up. The total incidence of patellar crepitus at one year in the Attune group was only 0.55%, compared with 6.26% in the PFC group. Similar results were also seen at two years post-operatively (0.83% vs 9.4%). When pre-operative range of motion, Knee Society Scores, age, gender, and BMI were controlled for in a multivariate linear regression model, the incidence of patellar crepitus was still lower in the Attune TKA group. Results here suggest that this substantial decrease in patellar crepitus is likely due, at least in part, to specific implant design changes in the Attune system. One of the strengths of this paper is the reporting of signs of crepitus and patient subjective sensation of symptoms. We would agree with the authors that this does support the hypothesis that patellar symptoms can be adequately addressed with relatively small design changes.

Ethnicity and knee revision rates

Despite the relative success of total knee arthroplasty (TKA) today, revision rates still hover between 2% and around 6% in the majority of reported series. Risk of revision is known to be highly sensitive to risk factors, with increased revision rates seen in patients who are young, have a higher number of medical comorbidities, and undergo surgery at a low volume institution. In the current study, researchers in **New York, New York (USA)** aimed to evaluate the relative contribution of race and/or socioeconomic status to overall risk of revision through a systematic literature review and meta-analysis of six studies.[3] The authors identified 4286 potential studies and reviewed them for possible inclusion in this review. The authors were able to identify six studies to be included in this meta-analysis and these were all performed in the United States, they included only primary TKA procedures, had follow-up to longer than two years, they reported revision rates and analysed race as an independent predictor of revision. All studies controlled for insurance status or included studies with a single payer. While insurance status may be a suitable surrogate for socioeconomic status, the authors readily acknowledged it is not a perfect substitute. The six included studies reported the outcomes of 451 960 patients undergoing primary TKA; 28 772 (6.4%) patients were black. Using a random effects model, pooled TKA revision hazard ratios were estimated and this suggested that black patients had a greater risk of revision than whites (HR 1.38; $p < 0.01$). Specifically, the

five-year revision risk was between 13% and 73% higher for blacks than whites after controlling for age, sex, comorbidities, insurance status, and hospital surgical volume. Additional comorbidity factors that were not controlled for include that blacks are more likely to have diabetes (a risk factor for infection), be at higher risk for arthrofibrosis, are less likely to use high-quality hospitals, and are more likely to be operated on by a trainee than an attending surgeon. Despite these confounders, this study does identify a specific problem with arthroplasty survival in one particular ethnic group. Clearly, more investigation is warranted here to establish whether this is due to modifiable risk factors, surgical or care quality factors, or perhaps even difficulties with implant design not matching differences in joint geometry.

BMI knee arthroplasty

The ongoing interest in body mass index (BMI) knows no boundaries. The authors of this study from **Rochester, Minnesota (USA)** took a fresh look at the outcomes of patients undergoing total knee arthroplasty (TKA) who are obese.[4] Although there is some evidence surrounding complications with the growing obesity epidemic, despite the major risk for complications there is perhaps no getting away from the fact that more and more obese patients will be undergoing arthroplasties including TKA. Current estimates would suggest that over 50% of adults undergoing TKA worldwide have a BMI $\geq$ 30 kg/m^2. Many studies have found an association between increasing BMI category and early complications such as superficial infection and thromboembolic events, however, the vast majority of studies have treated BMI as a categorical variable and, as such, have been unable to evaluate accurately the effect of increasing BMI on survival and post-operative complications. The basis of this study is the Mayo Clinic joint registry which has collated outcome data from 1985 to 2012, and includes a wealth of patient and operative data including demographic characteristics, operative details, re-operations, complications, and clinical outcomes. The outcomes of 22 289 primary TKAs performed in 16 136 patients were included in this study. The survival of the arthroplasties themselves and the effect of covariates were estimated using the Kaplan-Meier survival method and Cox proportional hazard regressions. The association was established between increasing BMI and re-operation and implant revision. Increasing BMI was positively associated with risk of ipsilateral re-operation, and implant revision/removal. BMI increases were also strongly correlated with risk of wound infection and deep periprosthetic joint infection (PJI) for a BMI of more than 35 kg/m^2. Perhaps surprisingly, increasing BMI was not associated with revision for tibiofemoral instability, risk of a thromboembolic event, or the need for a subsequent knee manipulation under anaesthesia. Patients with a BMI $>$ 35 kg/m^2 had significantly higher rates of revision or re-operation compared with patients with a BMI between 18 and 25 kg/m^2. The most clinically relevant finding of this paper was that the authors established a 5% increase in risk for any re-operation for every one unit increase in BMI over 30 kg/m^2, suggesting perhaps that even a small drop in BMI pre-operatively could significantly reduce the risk of complications post-operatively. In terms of infection, there was an 8% increase in risk for deep PJI for every unit increase in BMI above 35 kg/m^2. Operating on any patients with a BMI over 35 kg/m^2, and especially over 40 kg/m^2, carries an apparently not insignificant risk. It is important to counsel patients on the increased risk of revision, re-operation and infection, and steps should be taken to modify the increased risk. The data presented here by this large registry study suggest that minimal BMI reduction may significantly reduce risk for complications such as deep PJI and re-operation, and should be seriously considered as part of pre-operative risk stratification and planning.

Distraction or arthroplasty

Knee joint distraction (KJD) is an approach that has been adapted from the frame surgeons where it has found some supporters as a treatment for ankle arthritis. This new modification aims to be joint space-preserving through the use of an external fixation device to achieve joint distraction, with the goal of delaying total knee arthroplasty (TKA) in patients with symptomatic knee arthritis. Although not a terribly common procedure, KJD offers the tantalising option of a treatment option for young patients who would be at higher risk for subsequent revision surgery following TKA. Using an external distraction device based around two tubes with internal springs and eight fixation pins, the knee is distracted intra-operatively and in the early post-operative period to achieve approximately 5 mm of distraction. The external fixation device is removed after six weeks of partial weight bearing. The difficulty with KJD is that despite the fervour with which some surgeons recommend the treatment, there are few studies to support the approach. Knee surgeons in **Woerden (The Netherlands)** conducted their own randomised controlled trial to add some evidence to the value (or otherwise) of KJD when compared with TKA.[5] The authors assessed outcomes using a variety of outcome measures (WOMAC, KOOS, ICOAP, EuroQol-5D-3L, VAS-pain) and also reported complications of both procedures with a KJD with TKA at one year. Their study enrolled 60 patients, all aged 65 years and older with tibiofemoral osteoarthritis. Patients were randomised in a 2:1 fashion to either receive TKA (n = 40; mean age 55.2 $\pm$ 1.0 years) or KJD (n = 20; mean age 54.9 $\pm$ 1.8 years). Slightly unexpectedly, four patients withdrew from the TKA arm of the study, leaving 36 in the TKA group and 20 in the KJD group. Both WOMAC and KOOS scores improved from baseline to one year in both groups, and there was no difference in the magnitude of these improvements between treatment groups. However, patients receiving TKA showed better improvement in the quality of life subscale than did KJD patients. The KJD group did recover flexion better than TKA patients, however, the KJD group also suffered a number of complications. Following the assigned treatments, one patient from the KJD group continued to have persistent pain and elected to undergo TKA before reaching one-year follow-up. Admittedly, the most concerning complication in this study were the twelve (60%) KJD patients who developed pin site infections; ten cases were treated with oral antibiotics and two cases required IV antibiotics (one *Staph. aureus* sepsis from blood culture and one pyrexia of unknown origin). Five of the 36 (13.9%) TKA patients required manipulation under anaesthesia for stiffness. Unfortunately, despite the non-inferior clinical outcomes reported at one year when compared with a group of TKA patients, the risk of superficial and deep infection may outweigh any benefits that KJD offers. Although this is reported as a definitive study, with

the loss to follow-up and 2:1 randomisation some of the analyses presented must be underpowered. The difficulty of course is that in a group with a 60% infective complication rate, this also raises some questions about the potential for problems in the future with a total knee.

Two-stage or one-stage for infected knee replacements?

A failed two-stage exchange for periprosthetic joint infection (PJI) is a nightmare scenario. Successful treatment of what can be an extremely challenging clinical situation is of paramount importance, and knowing whether to attempt another two-stage revision or a fusion, particularly in the case of an immunocompromised patient, is difficult. The literature would suggest that two-stage exchanges for infected total knee arthroplasties (TKAs) fail in between 10% and 25% of cases, leaving the surgeon and patient with a difficult choice as subsequent surgical treatment options are then another two-stage exchange, arthrodesis, or amputation. Two-stage exchanges, if successful, offer return to function and better pain relief than arthrodesis or amputation. However, little is known about the relative success of a second attempt at a two-stage procedure in compromised hosts. The surgeons at the Mayo Clinic in **Rochester, Minnesota (USA)** have again come to the rescue and reported their retrospectively collated experience of 45 patients who had undergone two or more two-stage exchange arthroplasties for periprosthetic knee infection between 2000 and 2013.[6] Using the Musculoskeletal Infection Society (MSIS) staging system, patients were categorised based on infection type, host status (based on factors such as diabetes, chronic malnutrition, HIV infection, age ⩾ 80 years, and pulmonary insufficiency), and the extremity status (based on factors such as vascular insufficiency, presence of skin bridges, and subcutaneous abscesses). All 45 patients were considered to have late chronic infections, lasting more than four weeks in duration. Ten patients were considered medically healthy or uncompromised (MSIS Host Type A), 27 were considered compromised (MSIS Host Type B), and eight were substantially compromised (MSIS Host Type C). The extremities were considered uncompromised in nine patients (MSIS Extremity Status 1), compromised in 31 patients (MSIS Extremity Status 2), and substantially compromised in five patients (MSIS Extremity Status 3). The purpose of the study was to determine the rate of infection-free survival, risk factors for failure, and complications based on the aforementioned MSIS criteria. Final follow-up was to a mean of 74 months (24 to 132), with 28 (62%) patients undergoing subsequent revision surgery for any reason. Twenty-two (49%) of these failures were due to persistent infection; the remaining six were revised for mechanical instability and failure. Host and extremity status were both risk factors for failure. Re-infection occurred in 30% of uncompromised hosts, in 48% of compromised hosts, and in 75% of substantially compromised hosts. However, uncompromised hosts (MSIS Host Type A) with an Extremity Status of 1 or 2 had a 70% rate of success with a repeat two-stage exchange, and the results from this subgroup suggest that this approach remains an excellent option in this group of patients. Additional surgical complications of extensor mechanism disruption (n = 3), intra-operative fracture (n = 3), post-operative fracture (n = 2), aseptic loosening (n = 2), mechanical failure of the implant (n = 3), and instability (n = 2) were also seen. In fact, out of the whole cohort of 45 patients, just 11 patients were complication- and revision-free after their second two-stage exchange, underlining the high complication rates associated with this procedure. As perhaps all surgeons with any experience in this area would suspect, the success of a second two-stage exchange is highly dependent on the status of both the host and the wound. Patient expectations should be managed prior to moving forward with a second two-stage exchange, and for significantly compromised patients, other surgical options such as fusion and amputation may be more successful in eradicating the infection.

Pre-operative opioids and early revision

In the era of bundled payments and care pathways, adjusting modifiable risk factors is important for prolonged survival and success after procedures such as total knee arthroplasty (TKA). These investigators from **Seattle, Washington (USA)** have set out to establish if there are any associations between the endemic opioid use now seen widely in the USA and outcomes following joint replacement.[7] Opioid use and misuse is widely associated with morbidity and mortality but the question is, should it be a warning sign in those seeking arthroplasty? The authors of this topical study undertook a retrospective review of six years of patients who underwent TKA as part of the U.S. Veterans Affairs System. The records included opioid dosage and their duration of use. The authors classified more than three months of opioid use as long-term opioid use. The authors didn't review the notes themselves but used a machine learning algorithm to classify the revision based on the operative note. Outcomes were then compared through the construction of survival curves. There were 32 636 patients (overwhelmingly male at 94.4%) included in this study. Around 40% (n = 12,772) were long-term opioid users and there was a 2.2% early revision rate (within one year). There were a number of comorbidities that were associated with early failure in this group: chronic kidney disease (OR 1.76); diabetes (OR 1.11); and long-term opioid use (OR 1.40). The effect of long-term opioid use was sustained and the hazards analysis suggested a hazard ratio of 1.19 when the association with knee revision was calculated. Perhaps the most interesting part of this analysis was the computer-aided learning which was used to parse the English language operation notes to establish if these were for infection or not. A validation of this method established an accuracy of 0.94 and ROC analysis gave an AUC of 0.99. The authors of this study have determined that pre-operative opioid use for longer than three months prior to surgery was an independent risk factor for failure after TKA. There is of course a potential chicken and egg situation here – is it the opioid use, or the underlying personality type that are associated with dependence, the severity of disease or underlying frailty that is associated with a higher failure rate. In a relatively homogeneous group of male veterans it is slightly alarming to see such high odds ratios. We really would have liked to have seen some psychological scores, pain scores, comorbidity and frailty indices here which would help to tease out what the problem is. This may well not be a modifiable behavioural risk factor as the authors suggest, but actually indicative of an underlying patient characteristic. An interesting question is posed, however, more work is definitely needed here.

Hyaluronic acid injections and total knee arthroplasty

The rationing of knee arthroplasty is happening in all but name in the United Kingdom, and clinicians are being set a number of thresholds before the clinical commissioning groups will agree to pay for a joint replacement. This situation is starting to be reflected in other healthcare economies, with the use of functional scores and other criteria to determine (particularly in state-funded systems) who qualifies for specific interventions. Undoubtedly, this will mean increasing numbers of patients with knee osteoarthritis receiving extended

courses of non-operative management. Previously, there has been some enthusiasm for hyaluronic acid injections and this paper from **Chicago, Illinois (USA)** has some important messages for those who, in the past, have been advocates of this technique.[8] An intra-articular injection of hyaluronic acid (HA) has been proposed to improve the lubrication of the knee joint by enhancing the viscoelastic properties of the synovial fluid. Some have also suggested that it may have anti-inflammatory, as well as analgesic, properties. A number of meta-analyses have already been published on the subject, none of which has been encouraging, and some suggesting an adverse reaction to such a procedure. Despite this, the American Academy of Orthopaedic Surgeons (AAOS) guidelines in 2008 suggested that the evidence was inconclusive and the American College of Rheumatology (ACR) supported the use of HA injections in those who cannot tolerate anti-inflammatories. This interesting study looked at the use of HA injections in the USA, and how the cost-benefit analysis stacks up in comparison with other non-operative interventions. This is a retrospective cohort study which includes the outcomes of 244 059 patients who underwent a TKA between 2005 and 2012. Of these, a total of 35 935 patients (14.7%) had had at least one HA injection in the 12 months preceding their TKA. The mean number of injections received prior to their TKA was 3.6. Perhaps more surprisingly, the number of HA injections per 100 000 patients ranged from 24 030 in 2004 to a high of 30 914 in 2008, with each injection costing on average $310. That equates to a total cost of just over $40,000,000 over the study period! The use of hyaluronic acid accounted for 25.2% of costs for all types of knee osteoarthritis non-operative-related healthcare payments, whereas corticosteroids accounted for 18.2% and non-narcotic analgesic medication accounted for 22.9%. From this paper it is clear that HA injections are still widely utilised in the USA. While the number of patients receiving HA injections in the UK are much smaller in comparison, it is questionable whether any patients should receive these injections when the clinical evidence that it will improve symptoms is, on average, poor. With healthcare finances under considerable pressure, the provision of expensive injections that do not have an evidence base is difficult to justify. The current NICE guidance advocates the use of paracetamol, topical NSAIDS and oral NSAIDS as first line non-operative treatment. Other measures are also recommended such as weight reduction and exercise. However, interestingly, the guidance does say that HA is available to patients, although not recommended. In times of austerity, we do perhaps need to think about the little things as well as the large. If fewer HA injections are offered, there would be more funds available to pay for knee replacement.

Amputation after total knee arthroplasty

Thankfully, transfemoral amputation following a total knee arthroplasty (TKA) is very rare. The indications are usually recurrent infection resistant to treatment, soft-tissue damage, severe bone loss and previous failed knee salvage techniques. It is clearly important to understand the sequelae leading to an amputation, however, the literature to date has been somewhat sparse. This important work was a nationwide study led by a team from **Copenhagen (Denmark)** evaluating all patients in Denmark who underwent a transfemoral amputation to identify the incidence and causes of amputation following a failed TKA.[9] A total of 92 785 primary TKAs were performed nationally during a 17-year period from 1997 to 2013, and of these a reassuringly low 258 (0.27%) were followed by an amputation. A total of 143 (0.15%) were performed for reasons unrelated to the TKA, including peripheral vascular disease, malignant diseases, trauma, diabetic ulcers, neurologic disease and septic shock with peripheral gangrene. There were 115 (0.12%) amputations which were likely to have been undertaken for causes related to failure of the TKA. The 15-year cumulative incidence of amputation related to a failed TKA was 0.32% and had the highest point incidence in the first year, however, the year-on-year incidence of amputation changed very little during the study period, with the major cause of amputation being periprosthetic infection (95 cases or 83%) and, perhaps unsurprisingly, the most frequently isolated organism was *Staphylococcus aureus*. The authors emphasise that while, previously, amputation would have been considered, there are now better techniques of reconstruction in knee revision including the treatment of soft-tissue and bone loss with skin grafts, muscle flaps, extensor mechanism allografts and modular revision implants in the management of poor bone stock. However, before considering a complex reconstruction it is important to consider the patients, and in light of the previous paper from the Mayo clinic, surgeons would do well to consider that multiple surgical attempts to save a knee may be less satisfactory in the long run than an earlier amputation. In the amputation group the authors found a substantially higher proportion of patients with a history of significant lower limb trauma and rheumatoid arthritis compared with the general population. Indeed, patients with these diagnoses are known to have a higher risk of infection. The key message from this paper was that infection remains a small but significant risk for amputation following TKA. However, there are reasons to be hopeful as reconstructive techniques continue to improve the incidence of amputation should reduce. Furthermore, each patient must be treated as an individual case and the options for management should be explained carefully.

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