Total knee replacement (TKR) is an operation that can be performed with or without the use of a tourniquet. Meta-analyses of the available Level-1 studies have demonstrated that the use of a tourniquet leads to a significant reduction in blood loss. The opponents for use of a tourniquet cite development of complications such as skin bruising, neurovascular injury, and metabolic disturbance as drawbacks. Although there may certainly be reason for concern in arteriopathic patients, there is little evidence that routine use of a tourniquet during TKR results in any of the above complications. The use of a tourniquet, on the other hand, provides a bloodless field that allows the surgeon to perform the procedure with expediency and optimal visualisation. Blood conservation has gained great importance in recent years due to increased understanding of the problems associated with blood transfusion, such as increased surgical site infection (due to immunomodulation effect), increased length of hospital stay and increased cost. Based on the authors’ understanding of the available evidence, the routine use of a tourniquet during TKR is justified as good surgical practice.

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The use of a tourniquet in orthopaedic lower limb surgery has evolved considerably since its introduction. In total knee replacement (TKR) the use, or avoidance of, a tourniquet has been a matter of concern and debate amongst surgeons. From the authors’ standpoint, the advantages offered by the use of a tourniquet during TKR exceed the potential disadvantages. In addition, new designs of tourniquet that allow pressure to be varied according to the needs of the patient may enhance the benefits of their use, whilst reducing adverse problems.

What does the Level-1 evidence say?
Various randomised controlled trials (RCTs) have explored this topic and some systematic reviews and meta-analysis have been published. In a meta-analysis Tai et al evaluated eight RCTs and three high-quality prospective studies. They observed a statistically significant reduction in total blood loss when a tourniquet was used. However, they observed no difference when the evaluation was focused on post-operative blood loss alone. They strongly suggested that not using a tourniquet reduced the number of thromboembolic events (13% with the use of tourniquet versus 6.2% with no tourniquet). However, the studies evaluated did not account for the type of thromboprophylaxis, making the interpretation of data somewhat difficult. Another meta-analysis by Alcelik et al evaluated ten RCTs related to the use of tourniquet during TKR. The evaluation of intra-operative and total blood loss demonstrated a statistically significant advantage to be had by favouring the use of a tourniquet. No statistical differences in terms of post-operative blood loss, deep venous thrombosis (DVT), or pulmonary embolism (PE) were observed. They reported a significantly higher rate of minor complications (such as superficial wound infection, skin blistering and hematoma) when a tourniquet was used. More recently, additional Level-1 studies have been published that were not included in any of prior meta-analyses. One study by Ledinl, Aspenberg and Good demonstrated the total overt bleeding was less in the tourniquet group, however they found that the use of tourniquet was associated with a decreased range of movement (ROM) measured two years after surgery (tourniquet mean 113°; non-tourniquet mean 124°; 95% CI for difference between means: 5° to 17°; p = 0.001). However, the ROM was functionally adequate in both groups, making clinical significance of these findings somewhat dubious. A more recent RCT by Tai et al demonstrated the tourniquet is not only effective in...
reducing intra-operative blood loss, but also reduces excessive post-operative inflammation and muscle damage.

The intuitive level of pressure used in the tourniquet would appear to be potentially significant. It has been demonstrated both in pediatric knee surgery, and in foot and ankle surgery that the use of an automated method to evaluate limb occlusion pressure (LOP) provides the benefits of decreasing the tourniquet cuff pressure without compromising the quality of the bloodless surgical field. This technology has also proven effective in an RCT involving TKR patients. In this study it was observed that there were no cases of peri-prosthetic infections when a cuff pressure ≤ 225 mmHg was employed. This promising technology is worthy of further evaluation.

There are three main strategies for the use of a tourniquet in TKR:

1) The tourniquet may be inflated before the incision and deflated following confirmed hardening of the cement.
2) It can be inflated prior to cement application and deflated following hardening.
3) It can be inflated before the initial incision and deflated following completion of skin closure.

Kvederas et al compared these three strategies in a RCT, and demonstrated that having the tourniquet inflation before the incision with subsequent deflation after cement hardening may be superior in terms of blood loss and post-operative mobilisation.

What kind of information is still missing?
It should be noted that all the Level-1 evidence involved cases of primary TKR. It is unknown how the outcome of revision TKR can be influenced by the use of a tourniquet, or for example, their release after two hours of continuous application and reapplication. It is recognised that a longer case is associated with clinically relevant neurological lesions after primary or revision TKR, therefore the authors believe future investigation in the field of revision TKR (particularly in infected cases) and in difficult TKR cases is needed.

It is important to evaluate the outcome measures by which successful tourniquet use is currently defined. From the authors’ point of view, it appears that the use of a tourniquet is an excellent way of decreasing blood loss. Another important measure includes the ‘invasiveness’ of the surgical procedure, or the amount of surgical stress response evoked (irrespective of the time the tourniquet remains inflated). For example, does the use of tourniquet decrease the amount of stress response generated by the surgical procedure? The authors speculate that lower blood loss may be associated with a less robust surgical stress response, and suggest further investigation in this field is required. In addition, the role of the tourniquet on early and safe hospital discharge after TKR is unknown.

Some complications are associated with the use of a tourniquet. However, few of them are caused exclusively by their use. Most of the complications that may be related including vascular injuries, nerve lesions, thromboembolic events and cardiovascular events are likely to be multifactorial, and so a conclusive cause-effect relationship cannot be established. It is plausible that in a particular subset of patients, the use of a tourniquet ought to be avoided. However, current levels of evidence do not allow the unequivocal identification of those patients. Despite this, recommendations for the avoidance of tourniquet in patients with radiological evidence of popliteal artery calcification, no palpable pedal pulses or known peripheral vascular disease have been made, and a pre-operative vascular study should be sought in these patients.

Conclusion and recommendations
On the basis of the available evidence, the use of a tourniquet during primary TKR should be considered the standard of care unless a clear contraindication is generated by a pre-operative vascular investigation. New technology such as the use of patient specific limb occlusion pressure is promising, but further investigation is required. When one considers revision cases or reconstruction of knees with substantial deformities, the tourniquet is in the authors’ opinion likely to prove more beneficial than detrimental.

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References