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The Role of Drainage After Total Knee Arthroplasty

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1. Introduction

Total knee arthroplasty (TKA) is associated with significant postoperative blood loss for which blood transfusion might be necessary. The role of wound drainage is controversial. The use of drainage was believed to be effective in decreasing hematoma formation (Drinkwater and Neil 1995; Holt et al. 1997; Martin et al. 2004), which has been theoretically thought to decrease postoperative pain, swelling, and incidence of infection(Kim et al. 1998). However, a closed suction drainage system inevitably increases bleeding because the tamponade effect of a closed and undrained wound is eliminated. Though some studies have shown that drainage after TKA is not necessary(Adalberth et al. 1998; Niskanen et al. 2000; Esler et al. 2003; Parker et al. 2004; Jones et al. 2007), it is still widely used by orthopedic surgeons(Canty et al. 2003).

Surgeons who routinely drain total knee replacements may also use adjunctive measures such as autologous blood transfusion, use of fibrin tissue adhesive, compression bandaging and local ice packing(Gibbons et al. 2001; Kullenberg et al. 2006; Radkowski et al. 2007) to reduce the excessive blood loss from the drain. Recently, drain clamping has received increasing attention. Since most of the blood loss in TKA occurs during the first few postoperative hours (37% in 2 hours and 55% in 4 hours)(Jou IM 1993; Senthil Kumar et al. 2005), it seems reasonable to clamp the drain tube in the first few hours after TKA to temporarily create a tamponade effect for bleeding control. Various methods of clamping drain have been reported in the literature. However, no consensus has been achieved to date.

To clarify the role of drainage system after total knee arthroplasty, we conduct a review process in the present project. A comprehensive search was carried out and the articles regarding the drainage after surgery were reviewed. This review article focused on:

1. Effectiveness of postoperative drainage in TKA.
2. Safety and complications of postoperative drainage in TKA.
3. Effect of temporary drain clamping.

The purpose of this article is to analyze the pros and cons in using the drainage system after total knee arthroplasty and to provide practical information for orthopedic surgeons and medical care givers.

2. Search of literature

Our review team completed the search of electronic databases, including the Cochrane Central Register of Controlled Trials (2010), PubMed Medline (1966 to May 2011), and Embase (1980 to May 2011). We used the following search terms and Boolean operators: (drain OR drainage) AND (knee OR arthroplasty OR joint replacement). We also searched the reference lists of the relevant articles for any further associated studies. The criteria for inclusion in our study were: 1) reports dealing with patients undergoing primary TKA, 2) studies about postoperative drainage. After reviewing the titles and abstracts of the studies, we then determined if the study was appropriate for retrieval. These retrieved articles were reviewed by our review team. A consensus about the content of this review article was reached through out series of discussion.

3. Postoperative drainage

The effectiveness of wound drainage following TKA is still controversial. Some authors believed drains would reduce postoperative hematoma formation.(Drinkwater and Neil 1995; Holt et al. 1997; Martin et al. 2004) Postoperative drainage have been shown to provide a better wound outcome in orthopedic surgery.(Berman et al. 1990) Serous discharge from the wounds in TKA without drainage was a major concern of postoperative care.(Ovadia et al. 1997) Using a drain theoretically decreased postoperative pain, swelling, and incidence of infection(Kim et al. 1998).

Using a drain would facilitate the postoperative wound management. It is probably the most established benefit of the drainage in TKA. The number of dressing reinforcement was reported to be less in the drainage group.(Holt et al. 1997; Ovadia et al. 1997; Kim et al. 1998) Some other articles assessed the volume of blood in the dressing by measuring the weight of the dressing and found less weight in the drainage group.(Esler et al. 2003; Tao et al. 2006) In addition, Holt et al and Kim et al found that the area of ecchymosis is significant less in the drainage group.(Holt et al. 1997; Kim et al. 1998) Omonbude et al applied musculoskeletal ultrasound to measure the formation of hematoma and effusion on the fourth post-operative day and reported that the range of hematoma was less in the drainage group than the non-drainage group.(Omonbude et al. 2010) The above results of reinforcement of dressings and degree of ecchymosis and hematoma indicated the using a drain may reduce the leakage of blood from the joints and wounds.

According to a previous survey, most surgeons used closed suction drainage and believed that it would prevent from infection.(Canty et al. 2003) Many articles addressed this issue but failed to prove its effectiveness in the prevention of infection.(Holt et al. 1997; Ovadia et al. 1997; Kim et al. 1998; Esler et al. 2003; Tao et al. 2006; Cao et al. 2009; Lin et al. 2009; Tai et al. 2010a) A recent meta-analysis showed that the incidence of infection was 0.5% in the drainage group and 1.2% in the non-drainage group, but pooled data demonstrated no significant difference.(Zhang et al. 2011)

Thromboembolism is one of the most common complications after TKA, and is of great concern because of the associated increases in morbidity and mortality reported in the literature. To date, no approach to venous thromboembolic prophylaxis has been universally accepted by orthopedic surgeons. The methods of prophylaxis varied among the included studies. Using a drain in TKA theoretically reduces postoperative knee swelling

and may reduce the risk of thromboembolism. However, the evidence provided in the literature seems not to support this claim. Several studies compared the incidence of deep vein thrombosis between the drainage and non-drainage groups and all of them found no significant difference.(Holt et al. 1997; Adalberth et al. 1998; Mengal et al. 2001)

Dose using a drain increase the postoperative range of motion through reducing swelling? Several studies mentioned this issue but the results were disappointed.(Ovadia et al. 1997; Adalberth et al. 1998; Tao et al. 2006; Lin et al. 2009) All reports stated no significantly better range of motion after application of drainage. We believe that postoperative range of motion is influenced by many perioperative factors. Using a drain cannot alter the long-term range of motion.

Recently, more and more articles against the use of the drain in TKA have been published. (Adalberth et al. 1998; Crevoisier et al. 1998; Niskanen et al. 2000; Esler et al. 2003; Parker et al. 2004; Jones et al. 2007) These articles compared the outcomes of the conventional continuing drainage and non-drainage and showed that the drain system not only had no major benefits but also increased blood loss.

The number of patients requiring homologous blood transfusion was provided in several studies. Compared to the non-drainage group, the patients of the drainage group showed higher risk for excessive blood loss which required blood transfusion.(Ovadia et al. 1997; Esler et al. 2003; Cao et al. 2009) The postoperative drop of hemoglobin was also more severe in the drainage group.(Tai et al. 2010a) Longer hospital stay of the drainage group has also been reported in the same article. One possible reason was that the patients were unwilling to do physical activities with a drain inserted in their knees. Delayed rehabilitational programs kept them in the hospital for a longer time. However, this is still a controversial issue because hospital stay is affected by many confounding factors.

4. Make balance between pros and cons of drainage

According to the current evidence, we could not make a conclusion to either support using drainage or non-drainage strategies. The literature indicated that drainage after TKA reduced soft tissue ecchymosis and requirement for dressing reinforcement, but caused more blood loss and increased the blood transfusion rate. The literature also failed to support that drainage could reduce incidence of infection, deep venous thrombosis, or increase postoperative range of motion. Whether using drainage or not depends on each patient's clinical condition, surgeon's preference and consideration.

5. Effect of temporary drain clamping

Several reports regarding the delayed release of the drain have been published in the last decade. After surgery, reactive blood flow increases, with the peak flow appearing within five minutes once the tourniquet is deflated(Larsson et al. 1977). Most of the blood loss in TKA occurs during the first few postoperative hours.(Jou IM 1993; Senthil Kumar et al. 2005) Control of the bleeding is very important during this period. This may be the reason that temporary clamping of the drain tube can significantly reduce the volume of the drained blood.

The ideal drainage system would decrease hematoma formation and not cause excess blood loss. Some blood-saving strategies such as the autologous blood reinfusion, fibrin

sealant, pharmacological intervention, or other additional management have been reported to achieve this goal. The drain clamping method, if it is effective, is a much easier way to reduce blood loss compared to these interventions. The initial clamping provides a temporary tamponade effect, as well as the delayed release prevents hematoma formation.

An earlier study(Kiely et al. 2001) about the clamping drainage was reported in 2001 and it claimed that there was no significant difference between the clamping and non-clamping drainage groups in volume of drained blood, transfusion requirements, knee motion or wound status. However, several following studies(Shen et al. 2005; Tsumara et al. 2006; Raleigh et al. 2007; Stucinskas et al. 2008) showed that the drained volume was decreased by temporarily clamping the drain tubes. The other one(Eum et al. 2006) involving the 1-hour clamping method demonstrated a significant decrease in the drained volume in the clamping group during the postoperative 24 hours, but not 48 hours. The total drained blood volume ranged from 297 to 807 ml in the clamping group and 586 to 970 ml in the non-clamping group in the literature.

No matter clamping or not, most of the patients showed similar postoperative hemoglobin levels.(Kiely et al. 2001; Shen et al. 2005; Eum et al. 2006; Tsumara et al. 2006; Stucinskas et al. 2008) Only one study revealed higher postoperative hemoglobin level in the clamping group.(Raleigh et al. 2007) The number of patients requiring transfusion was provided in four studies(Shen et al. 2005; Eum et al. 2006; Tsumara et al. 2006; Stucinskas et al. 2008). One study(Eum et al. 2006) claimed that no transfusions were administered in either group. Shen et al.(Shen et al. 2005) reported similar transfusion rates in the both group. The other two articles(Tsumara et al. 2006; Stucinskas et al. 2008) showed slightly lower transfusion rates with clamped drains. Recently, administration of tranexamic acid and carbazochrome sodium sulfonate hydrate in the drain-clamping method was reported to reduce bleeding after TKA without increasing the risk of deep venous thrombosis.(Onodera et al. 2011)

It seemed that the results about blood loss were heterogeneous. One of the main reason might be the various clamping time in these trials. The debate on the length of time for which the drain should be clamped is still going on. Periods of between 1 and 24 hours have been reported.(Ryu et al. 1997; Kiely et al. 2001; Yamada et al. 2001; Prasad et al. 2005; Shen et al. 2005; Roy et al. 2006; Tsumara et al. 2006; Raleigh et al. 2007; Stucinskas et al. 2008) Some intermittent clamping methods have also showed their effectiveness in bleeding control(Prasad et al. 2005; Tsumara et al. 2006). A meta-analysis of the randomized controlled trials showed that the clamping methods could reduce the true blood loss only when the drain was clamped for four hours or more.(Tai et al. 2010b) We found three trials dealing with the two-hour, one-hour, and half-hour clamping methods and then showing no reduction in true blood loss.(Kiely et al. 2001; Eum et al. 2006; Tsumara et al. 2006) These findings suggest that when using the clamping methods to manage the drainage system after TKA, the ideal clamping period should be four hours or more. However, the patients managed with the longer duration of drain-clamping may have less blood loss but may also eliminate the potential advantages of the drainage. In addition, the situation of long clamping is similar to that of non-drainage; therefore, it is not logical for clinical practice.

Some studies(Kiely et al. 2001; Shen et al. 2005; Tsumara et al. 2006; Stucinskas et al. 2008) mentioned the effect of clamping drainage on postoperative range of motion of the knee. In

these studies, the timing of measuring the range of motion varied from 6 to 83 days postoperatively. However, no significant difference was found in this issue. This finding suggested that although clamping the drain might potentially keep the knee swollen and reduce the range of motion shortly after operation, the influence did not persist.

For incidence of thromboembolic events, the previous trials demonstrated no difference in the between of the clamping and non-clamping groups. The pooled results of a recent meta-analysis also suggested that the temporary clamping methods did not significantly increase the risk of thromboembolic events. The symptomatic events occurred in 2.9% (7/244) of patients in the clamping group and 1.2% (3/259) in the non-clamping group (relative risk: 2.25, $p = 0.17$). The reported wound problems of these trials included severe oozing, bruising, blistering, partial breakdown, wound infection, and cellulitis. Another study reported an episode of transient hypotension upon release of the drain that resolved spontaneously.(Kiely et al. 2001) Again, no significant difference was found between the clamping and non-clamping groups regarding these complications.

In summary, the available evidence indicated that temporarily clamping the drains after TKA decreased the volume of drainage, but only clamping for not less than four hours decreased the reduction in hemoglobin levels. Although clamping does not increase the complication rate, its effectiveness and necessity is still questionable.

6. Authors' preference

For the past decade, we have focused on the studies about the role of the drainage system after total knee arthroplasty. In the first observational study, we found then most of the blood loss in TKA occurs during the first four postoperative hours.(Jou IM 1993; Senthil Kumar et al. 2005) Then we conducted a randomized controlled trial to check the effectiveness of four-hour temporary clamping drainage and found it is an effective method to reduce postoperative blood loss after total knee arthroplasty.(Shen et al. 2005) We also published a meta-analysis of the randomized controlled trials comparing outcomes between the various drain-clamping methods and immediately open drainage after TKA.(Tai et al. 2010b) We focused on blood loss and complications to evaluate the pros and cons of drain clamping. A trial comparing four-clamping drainage and non-drainage was conducted and revealed the role of drainage is still questionable after total knee arthroplasty.(Tai et al. 2010a) Despite clamping the drain for the first four hours after TKA, we found that the patients with drainage showed more blood loss and gained no other benefit compared with those without a drain. Although the clamping drainage was superior to the conventional drainage according to previous literature, we found no advantage of using this method compared with non-drainage. Thus, we did not routinely use the drainage system in primary total knee arthroplasty in our daily practice.

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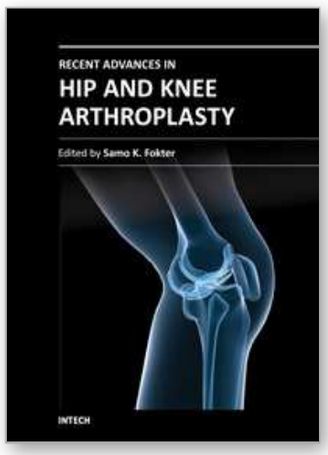
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The purpose of this book is to offer an exhaustive overview of the recent insights into the state-of-the-art in most performed arthroplasties of large joints of lower extremities. The treatment options in degenerative joint disease have evolved very quickly. Many surgical procedures are quite different today than they were only five years ago. In an effort to be comprehensive, this book addresses hip arthroplasty with special emphasis on evolving minimally invasive surgical techniques. Some challenging topics in hip arthroplasty are covered in an additional section. Particular attention is given to different designs of knee endoprostheses and soft tissue balance. Special situations in knee arthroplasty are covered in a special section. Recent advances in computer technology created the possibility for the routine use of navigation in knee arthroplasty and this remarkable success is covered in depth as well. Each chapter includes current philosophies, techniques, and an extensive review of the literature.

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