Blood Management and Venous Thrombo-Embolic Complications in Total Knee Replacement

Dr. Wong Yiu Chung
Director
Total Joint Replacement Centre, YCH
Our Background

First designated centre in Buddhist Hospital 2010
Second in YCH Oct 2011

total hip + knee replacements
500/year which is 1/6 of HA

18 beds

Shorten TJR surgery waiting time
multidisciplinary approach
## Referral from 16 HA hospitals

<table>
<thead>
<tr>
<th>Year</th>
<th>Waiting Time for First Appointment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>4 mth</td>
</tr>
<tr>
<td>2012</td>
<td>9 mth</td>
</tr>
<tr>
<td>2013</td>
<td>4 mth</td>
</tr>
<tr>
<td>2014</td>
<td>9 mth</td>
</tr>
</tbody>
</table>

### Maximum Quota

<table>
<thead>
<tr>
<th>Year</th>
<th>Maximum Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>600</td>
</tr>
<tr>
<td>2012</td>
<td>600</td>
</tr>
<tr>
<td>2013</td>
<td>600</td>
</tr>
<tr>
<td>2014</td>
<td>600</td>
</tr>
</tbody>
</table>

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*Note: The image includes a graph showing referral data from 16 HA hospitals.*
Blood Management
Blood loss reduction + Blood management protocol → Blood transfusion
CURRENT CONCEPTS REVIEW

Perioperative Blood Transfusions in Orthopaedic Surgery

Karthikeyan E. Ponnusamy, MD, Thomas J. Kim, MD, and Harpal S. Khanuja, MD

Investigation performed at the Department of Orthopaedic Surgery, The Johns Hopkins University, Baltimore, Maryland

- Blood transfusion after orthopaedic surgery accounts for 10% of all packed red blood-cell transfusions, but use varies substantially across hospitals and surgeons.
- Transfusions can cause systemic complications, including allergic reactions, transfusion-related acute lung injury, transfusion-associated circulatory overload, graft-versus-host disease, and infections.
- Tranexamic acid is a new cost-effective blood management tool to reduce blood loss and decrease the risk of transfusion after total joint arthroplasty.
- Current clinical evidence does not justify transfusions for a hemoglobin level of >8 g/dL in the absence of symptoms.
- Studies have also supported the use of this trigger in patients with a history or risk of cardiovascular disease.
Transfusion complications

1. Allergic reactions
2. Transfusion-related lung injury
3. Transfusion-associated circulatory overload
4. Venous thrombo-embolism
5. Graft-versus-host disease
6. Blood-borne infections
7. Immunomodulation
<table>
<thead>
<tr>
<th>Complication</th>
<th>Prevalence (%)</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allergic reaction</td>
<td>0.15 to 15*</td>
<td>&lt;1*</td>
</tr>
<tr>
<td>Transfusion-related acute lung injury</td>
<td>0.08 to 15</td>
<td>5 to 10</td>
</tr>
<tr>
<td>Transfusion-associated circulatory overload</td>
<td>1 to 11†</td>
<td>2 to 15†</td>
</tr>
<tr>
<td>Graft-versus-host disease</td>
<td>&lt;1</td>
<td>84 to 100§</td>
</tr>
</tbody>
</table>

*Data are from Hirayama¹². †Data are from Alam et al.¹¹ and Lieberman et al.¹⁴. ‡Data are from Alam et al.¹¹, Lieberman et al.¹⁴, Menis et al.¹⁵, and a U.S. Food and Drug Administration report¹⁶. §Mortality rates for severe reactions. Milder presentations are not diagnosed, and consequently overall mortality rates are unknown.
# TABLE V Strategies to Reduce the Need for Transfusion

<table>
<thead>
<tr>
<th>Timing</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>Iron therapy, intravenous erythropoietin, autologous blood transfusion, and discontinuation of anticoagulation medicines (aspirin and nonsteroidal anti-inflammatory drugs)</td>
</tr>
<tr>
<td>Intraoperative</td>
<td>Pharmacologic: fibrin sealants, desmopressin, thrombin, lavage with epinephrine or norepinephrine, epsilon-aminocaproic acid, and tranexamic acid; Nonpharmacologic: normovolemic hemodilution, hypotensive anesthesia, tourniquets, bipolar sealants, and cell saver</td>
</tr>
<tr>
<td>Postoperative</td>
<td>Autologous blood transfusion drains and not using drains</td>
</tr>
</tbody>
</table>
Average rate of ABT & average unit of blood given from 2004 to 2012 for TKR in HA
Measures to decrease blood loss

- Continuous suture of arthrotomy wound
- Tourniquet
- Drainage reduction
Drainage reduction protocol*

**Past**
- High pressure drainage
- 2-3 days
- 800-1000ml
- Hb loss 3-4g/dl
- Delayed ROM exercise

**Now**
- Low pressure (200mmHg)
- 1 day
- 200-300ml
- Hb loss 2g/dl
- Earlier ROM exercise

*Drain versus no drain in total knee replacement: A matched prospective cohort study using short duration and low suction pressure protocol. Lee QJ, Mak WP, Yeung ST, Wong YC, Wai YL.
The use of drain in total knee replacement –
A prospective cohort study using short duration and low suction pressure protocol

Dr. Lee Quinn Jid
Dr. Hau Wai Sun
Ms Mak Wai Ping
Dr. Yeung Sze Tsun
Dr. Wong Yiu Chung
Dr. Wai Yuk Leung

Joint Replacement Center
Yan Chai Hospital
Introduction

• The use of drain in total knee replacement is controversial.

• Many studies have shown no differences in the incidence of wound infection, haematoma formation, dehiscence, reoperation with or without drain.
Primary total knee replacement in Sep 2012-Mar 2013 (n = 203)

Eligible (n = 175)

Excluded (n = 28)
  - Bilateral (n = 16)
  - Subvastus (n = 12)

No drain cohort (n = 97)
  Intervention period: Sep 2012-Dec 2012

Drain cohort (n = 78)
  Intervention period: Jan 2013-Mar 2013

Materials and Methods
Materials and Methods

• Specific protocol for drain:
  – suction pressure of 200mmHg
  – taken off 24 hours after surgery
Results

– Drain with low pressure-short duration protocol:

• Significantly better in-patient outcome (Knee & calf swelling, Quad power)

• Trend of better early results (6M ROM, knee and function score)

• No increase in hemoglobin drop and transfusion rate
Discussion

• **Optimal timing of drain removal** in TKR:
  – Drinkwater et al. *J Arthroplasty* 2005

  • drain output
    - 76% 0-24 hours
    - 18% 24-48 hours
    - 6% 48-72 hours

  • contamination
    - 9% 0-24 hours
    - 18% 24-48 hours
    - 35% 48-72 hours
Discussion

- Optimal pressure:
  - Morgan Jones et al, *The Knee 2000*
    - 375mmHg vs 125mmHg (max)
  - Cheung, Chiu, *JOS 2006*
    - 600mmHg vs 350mmHg

- Both concluded:
  - Lower pressure less blood loss
Discussion

• **24 hour + 200mmHg drain:**

  The mean drain output was around **200ml**.

  • Compared with normal pressure drain with output of around 800-1000ml
  • avoid excessive blood loss and blood transfusion

  • Compared with no drain, adequate to reduce large knee and calf swelling, improve quadriceps power
Blood management protocol*

**Past**
- Routine x-match
- Transfusion threshold 10g/dl
- Repeated blood taking
- Transfusion rate: 20-30%

**Now**
- T & S if Hb <11g/dl
- Top up Hb to 10g/dl pre-op
- Transfusion threshold 8g/dl
- Transfusion rate: 6% (fewer transfusion rxn, PJI)

Reference:

*Cross-match and transfusion protocol in total knee replacement: an effective way to reduce blood waste and unnecessary transfusion. Lee QJ, Mak WP, Yeung ST, Wong YC, Wai YL.
Blood management protocol for total knee arthroplasty to reduce blood wastage and unnecessary transfusion

Quan-jie Lee, Wai-Ping Mak, Sze-Tsun Yeung, Yiu-Chung Wong, Yuk-Leung Wai
Joint Replacement Centre, Yan Chai Hospital, Tsuen Wan, Hong Kong

ABSTRACT

Purpose. To compare outcomes of 2 cohorts of patients who underwent total knee arthroplasty (TKA) before and after the introduction of a blood management protocol.

Methods. Records of 97 and 96 consecutive patients who underwent unilateral TKA before and after introduction of the blood management protocol, respectively, were reviewed. Before introduction of the protocol, patients were cross-matched for blood before surgery. Transfusion after surgery was at the discretion of the surgeons or the on-call doctors. After introduction of the protocol, only patients with a preoperative haemoglobin level of 110 g/l underwent 'type and screening' of blood group. 2 units of blood were cross-matched preoperatively when multiple red-cell antibodies were identified or postoperatively when blood transfusion was required. Only patients with a postoperative haemoglobin level of 80 g/l or being symptomatic received blood transfusion until the haemoglobin level reached 100 g/l. Those with a postoperative haemoglobin level of 80 to 100 g/l were given iron sulphate 300 mg twice daily for a month.

Results. The 2 groups did not differ significantly in age, sex ratio, pre- and post-operative haemoglobin levels, and drain output. Comparing outcome before and after introduction of the protocol, the transfusion rate (10.3% vs. 3.1%, p = 0.046), cross-match rate (100% vs. 3.1%, p < 0.001), and cross-match to transfusion ratio (9.7:1 vs. 1:1, p = 0.001) decreased. Among transfused patients, the decreased postoperative haemoglobin level indicated a lower transfusion trigger point (100 g/l vs. 75 g/l, p = 0.006).

No patient developed infection, cardiovascular or cerebrovascular complications within 30 days.

Conclusion. The blood management protocol for TKA is effective in reducing unnecessary autologous blood transfusions and wastage of unused blood, without an increase in postoperative complications.

Key words: arthroplasty, replacement, knee; blood grouping and crossmatching; blood transfusion
Materials and methods

• 193 primary TKR were reviewed.
• Two cohorts (97 vs 96)
  – No-protocol group: 97 consecutive patients from 2009 to 2011.
  – Protocol group: 96 consecutive patients from February to May 2012.
Materials and methods

• No-protocol group:
  - All had cross-match before operation.
  - Transfusion was performed at pre-op, op or post-op at the discretion of the anesthetists, surgeons or the on-call doctors without unified guideline.

• Protocol group:
  - Type and Screen
    pre-op only if Hb < 11g/dl.
  - Blood transfusion only if:
    - post-operative D1 Hb < 8g/dl or the patient was symptomatic.
    - aim: top up the hemoglobin level to above 10g/dl (with minimum amount required)
  - Iron sulphate 300mg twice daily for a month if Hb 8-10g/dl
Result

• With Blood Management Protocol
  – Cross-match rate dropped drastically (100% → 3%)
  – Transfusion rate dropped significantly (10% → 3%)
Discussion

• Various measures in reducing allogenic blood transfusion in TKR

  – Pre-operative autologous blood donation:
    • requires multiple attendances in a specified period to the single Red-Cross centre,
    • difficult for elderly,
    • large wastage of predonated blood.

  – Cell-saver
    • requires specialized personnel to operate,
    • long preparation time,
    • in TKR, intraoperative bleeding with tourniquet on is minimal

  – Autotransfusion
    • drainage system needs special handling,
    • transfused back within six hours after operation,
    • requires significant quantity to be effective,
    • Risks: febrile reaction, infection, thromboembolism, air embolism, fat embolism and clotting disorder.
Discussion

• Protocol: Low transfusion trigger point (8g/dl)
  May be associated with lower infection rate, respiratory complications without increase in mortality

  – Our transfusion rate dropped significantly (10% → 3% )
    • which was among the lowest in literature and in our locality
    • without any increase in morbidity and mortality
    • without any change in surgical technique or additional perioperative measures.
Performance of the HA hospital in ABT from 2004 to 2012

![Graph showing the rate of ABT after primary TKA from 2004 to 2012. The graph indicates that YCH has the highest rate of ABT in the 30%-40% category.](image-url)
Venous Thrombo-Embolism
Introduction

Deep Vein Thrombosis

Patients following total knee arthroplasty are at risk 50% to 80% in Western population (RH Fitzgerald; et al: JBJS A)

Pulmonary Embolism

Fatal PE: 0.15% in Scottish Registry
Non-fatal PE: 0.44% California

No change in symptomatic/fatal PE for >10 years following American College of Chest Physicians (ACCP) guidelines
Pathophysiology

- Peripheral venous **stasis**
  - Operative maneuvers
  - Immobilization after operation
- Direct endothelial injury
- Increase blood coagulability
16. Summary
Deep vein thrombosis is not an uncommon phenomenon in local Chinese population.
Some forms of prophylaxis should be considered at least in some of these patients undergo total hip or knee replacement.
Venous Thromboembolic Disease After Total Hip and Knee Arthroplasty

• The ideal prophylaxis modality clinically effective without side effects, be practical and easy to use, require no monitoring, and be cost-effective.

• balancing of the risk of clots against the risk of bleeding.
Pharmacologic Prophylaxis

1. Low Molecular Weight Heparin - parenteral route, cost, complications and bleeding
2. Warfarin – less potent then LMWH, monitor INR
3. Aspirin – less effective
4. Direct Factor IIa inhibitor (oral Dabigatran, Hirudin, Desirudin)
5. Factor Xa inhibitor (Fondaparinux, oral Apixaban, oral Rivaroxaban)
Mechanical Prophylaxis

• Graduated pressure stockings
  ![Graduated pressure stockings](image1.png)

• Foot pumps, calf pumps, calf/thigh pumps
  ![Foot pumps, calf pumps, calf/thigh pumps](image2.png)

• Low complication rates
• But compliance issues
Overview

No differences, in terms of the
- total pulmonary embolism rate,
- fatal pulmonary embolism rate,
- total death rate, or
- death rate from bleeding,
among the different thromboembolism prophylaxis interventions.

The prevalence of major bleeding associated with the combined intervention of mechanical prophylaxis and aspirin was very low
5. We suggest the use of pharmacologic agents and/or mechanical compressive devices for the prevention of venous thromboembolism in patients undergoing elective hip or knee arthroplasty, and who are not at elevated risk beyond that of the surgery itself for venous thromboembolism or bleeding. (Grade of Recommendation: Moderate) Current evidence is unclear about which prophylactic strategy (or strategies) is/are optimal or suboptimal. Therefore, we are unable to recommend for or against specific prophylactics in these patients. (Grade of Recommendation: Inconclusive) In the absence of reliable evidence about how long to employ these prophylactic strategies, it is the opinion of this work group that patients and physicians discuss the duration of prophylaxis. (Grade of Recommendation: Consensus)

6. In the absence of reliable evidence, it is the opinion of this work group that patients undergoing elective hip or knee arthroplasty, and who have also had a previous venous thromboembolism, receive pharmacologic prophylaxis and mechanical compressive devices. (Grade of Recommendation: Consensus)

7. In the absence of reliable evidence, it is the opinion of this work group that patients undergoing elective hip or knee arthroplasty, and who also have a known bleeding disorder (e.g., hemophilia) and/or active liver disease, use mechanical compressive devices for preventing venous thromboembolism. (Grade of Recommendation: Consensus)

8. In the absence of reliable evidence, it is the opinion of this work group that patients undergo early mobilization following elective hip and knee arthroplasty. Early mobilization is of low cost, minimal risk to the patient, and consistent with current practice. (Grade of Recommendation: Consensus)
Lower incidence of DVT in HK?

Clinical Orthopaedics 1980
The Pattern of Deep-Vein Thrombosis and
Clinical Course of a Group of
Hong Kong Chinese Patients Following Hip Surgery
for Fracture of the Proximal Femur

C. K. Mok, F.R.C.S.E., F. T. Hoaglund, M.D.,* S. M. Rogoff, M.D.,**
S. P. Chow, F.R.C.S.E., and A. C. M. C. Yau, F.R.C.S.E.

32 days later. The patients were followed for 27
to 32 months. The phlebographic pattern of the
venous thrombi were analyzed, and the clinical
course of the patients was presented. Despite
the fact that the overall incidence of deep-vein
thrombosis in this group of Chinese patients
was similar to that reported in the West, clinical
pulmonary embolism was not observed. The
study suggested a difference in the distribution,
Deep Venous Thrombosis After Total Hip or Knee Arthroplasty in a “Low-Risk” Chinese Population

P. S. Ko, FRCS(E), FHKAM(Orth),* W. F. Chan, FRCS(E),*
T. H. Siu, FRCR, FHKAM(Radiology),† J. Khoo, FRCR, FHKAM(Radiology),†
W. C. Wu, FRACS(Orth), FHKAM(Orth),* and J. J. Lam, FRCS(E), FHKAM(Orth)*

Abstract: Scarcely any information has been published on deep vein thrombosis (DVT) in Chinese patients after total hip arthroplasty (THA) or total knee arthroplasty (TKA). However, generally, no prophylaxis is given to patients who do not have conventional high-risk factors because they are believed to be at “low risk.” We performed a prospective study on 80 such “low risk” patients undergoing THA or TKA (58 TKA and 22 THA) without prophylaxis and performed duplex ultrasonography on both lower limbs 6 to 8 days after surgery. A total of 22 patients (27.5%) showed ultrasonographic evidence of DVT. Eighteen (31%) TKAs and 4 (18.1%) THAs were complicated by DVT. Three patients showed bilateral involvement, all of whom underwent TKA. Two patients had symptomatic pulmonary embolism. The sensitivity and positive predictive value of the clinical examination was 27.2% and 31.6%, respectively. This study showed that patients who are labeled “low risk” for DVT actually had a significant risk and suggests that the current practice of providing prophylaxis to only patients deemed at “high risk” should be revised. Key words: thromboembolic disease, Chinese, ultrasonography, arthroplasty.

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Deep vein thrombosis after total knee arthroplasty in asian patients without prophylactic anticoagulation.

Chung LH1, Chen WM, Chen CF, Chen TH, Liu CL.
1Department of Orthopedics and Traumatology, Taipei Veterans General Hospital, Taipei, Taiwan, Republic of China.

Abstract
Deep vein thrombosis (DVT) is an important complication following total knee arthroplasty (TKA). However, the incidence of DVT is generally underestimated due to subclinical or minor symptoms and signs. In Western countries, prophylactic agents against DVT are administered routinely after TKA. However, in Asia, no regular prophylaxis is generally given to patients undergoing TKA. This article presents a prospective study evaluating the incidence of DVT in 724 consecutive Taiwanese patients who underwent TKA without prophylactic anticoagulation therapy. Of these, 328 patients (45.3%) showed positive Homan's sign with calf swelling >3 cm. Ultrasonographic examination revealed the overall incidence of DVT to be 8.6% (62/724). The incidence of DVT was significantly higher in women (P=.035), in patients who underwent bilateral TKA (P=.002), and in patients with a body mass index ≥30 kg/m² (P=.026). The incidence of DVT appeared to be increased in patients with higher tourniquet time; however, the difference was not statistically significant. In all of the suspected cases of DVT, the symptoms subsided after the administration of enoxaparin with uneventful follow-up. No patient developed pulmonary embolism. Our results showed a relatively high incidence of DVT in an Asian population following TKA. We therefore consider that following TKA, prophylactic anticoagulation therapy should be administered to high-risk patients.
Original Article

A Prospective Study of Venous Thromboembolic Prophylaxis Using Foot Pumps Following Total Knee Replacement in a Chinese Population

Wong Yiu-Chung a,*, Cheung Ho-Yin b, Li Pang-Hei a, Lee Qunn Jid a, Wai Yuk-Leung a, Wong Chan-Wah c

a Department of Orthopaedics and Traumatology, Yan Chai Hospital, Hong Kong SAR, China
b Department of Orthopaedics and Traumatology, Kwong Wah Hospital, Hong Kong SAR, China
c Department of Radiology, Yan Chai Hospital, Hong Kong SAR, China

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ABSTRACT

Purpose: The purpose of this study was to evaluate foot pumps as mechanical prophylaxis for deep vein thrombosis (DVT) following total knee replacement (TKR) in a Chinese population.

Methods: All consecutive patients following TKR during 2002–2006 received routine duplex ultrasound surveillance for DVT 9 days postoperatively. The demographic data and risk factors were recorded. No medication was given for DVT prophylaxis in all patients.

Results: We evaluated 91 consecutive TKRs in 85 patients. Although 44 knee replacements (Group 1) done before December 2004 were not given foot pumps, 47 knee replacements (Group 2) done afterwards were given foot pumps. All patients were followed up for more than 6 months. DVT was detected in three cases (6.8%) in Group 1 compared with four knees (8.5%) in Group 2. Proximal thrombosis was observed in two knees (4.3%) in Group 1 compared with two knees (4.3%) in Group 2. No patient had pulmonary embolism. Six out of 55 (10.2%) patients who underwent the operations under general anaesthesia suffered from DVT, whereas one in 28 (3.6%) patients operated under spinal anaesthesia had DVT. All had no statistical significance.

Conclusion: The rate of proximal DVT after TKR was low (4.5%) without pharmacological prophylaxis. We advise against the use of pharmacological prophylaxis in Chinese population for TKRs because of the low risk of proximal DVT and its possible bleeding complications. Foot pumps did not lower the rate of DVT further, and its use for DVT prophylaxis in TKR is not necessary.
The incidence of deep vein thrombosis and its natural history following unilateral primary total knee replacement in local Chinese patients

A prospective study

2012

Dr. Lai Chun Kit
Dr. Lee Qunn Jid
Dr. Yeung Sze Tsun
Dr. Wong Yiu Chung
Dr. Wai Yuk Leung
Material and Method

- **390 patients** in 1 year from 2012

- **mechanical prophylaxis with foot pump** in all patients

- **chemoprophylaxis (86 cases)** was given if
  - BMI > 30 (79 cases) or
  - history of venous-thromboembolism (7 cases)
Conclusion

• **Distal DVT** : 25%
  FU scan at 1 and 6 weeks later
  57% resolved after 6 weeks
  1% progression to proximal DVT

• **Proximal DVT** : 1%

• **Clinical Pulmonary Embolism or Mortality** : 0%

• **No difference between General Anaesthesia and Spinal Anaesthesia**
2011 – 2014  (1260 TKRs)

DVT
All TJR have routine US surveillance at ~ D5

Proximal  12/1260 = 1.0%
(Oct 2011 – Feb 2014)

Pulmonary Embolism  1/1039 = 0.1%
Summary

• Fast surgery
• Ambulation on day one
• All have foot/calf pumps + graduated pressure stockings
• Pharmacological prophylaxis for high risk patients, eg, history of VTE
• Our hospital is the only hospital having routine ultrasound surveillance
• Our proximal DVT/PE rate were very low
• Treatment of proximal DVT /PE only, not distal DVT
## Complications
### (4Q 2011 – 3Q 2013)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Dislocation</td>
<td>3/151</td>
<td>1.99%</td>
</tr>
<tr>
<td>Proximal DVT</td>
<td>7/1039</td>
<td>0.67%</td>
</tr>
<tr>
<td>Distal DVT</td>
<td>202/995</td>
<td>20.3%</td>
</tr>
<tr>
<td>PE</td>
<td>1/1039</td>
<td>0.1%</td>
</tr>
<tr>
<td>Surgical Site Infection</td>
<td>5/1039</td>
<td>0.48%</td>
</tr>
<tr>
<td>AROU (2011-2014)</td>
<td>253/1615</td>
<td>15.7%</td>
</tr>
<tr>
<td>UTI</td>
<td>3/1039</td>
<td>0.29%</td>
</tr>
<tr>
<td>Fall (2013-14)</td>
<td>6/1044</td>
<td>0.57%</td>
</tr>
<tr>
<td>MUA (TKR)</td>
<td>19/888</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

Reference: