An ultrasound evaluation of the incidence of deep vein thrombosis in the operated and non-operated contralateral lower limbs following unilateral total knee replacements

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Purpose

Total knee replacement (TKR) is a successful surgery that improves mobility and the quality of patients' lives.\textsuperscript{1,2} However, lower limb deep vein thrombosis (DVT) and pulmonary embolism (PE) are the main complications of this surgery.\textsuperscript{2} Therefore, post-operative pre-discharge DVT screening ultrasound scans have been implemented in many institutions, including both major tertiary hospitals in Singapore, the National University Hospital (NUH) and the Singapore General Hospital (SGH).\textsuperscript{2,10}

Most of the published studies focused on detecting the DVT incidence rates after lower limb joint replacements.\textsuperscript{2-29,34-38} Very few studies had reported the incidence and distribution of DVT in the non-operated contralateral lower limb of patients who underwent unilateral TKRs, or discussed the possibility of only scanning the operated limbs.

This retrospective study was designed to investigate the incidence and distribution of DVT in both lower limbs of local patients who underwent unilateral TKRs. The aims of this study are:

- To determine and compare the incidence of DVT in the operated lower limbs with the non-operated contralateral lower limbs in patients who have undergone unilateral TKRs, on POD three to seven.
- To compare the incidence and distribution of DVT in Singaporean TKR patients with a Western population.
Methods and Materials

A retrospective study on all patients who had undergone unilateral TKR (Fig. 1) at National University Hospital of Singapore between 1 March 2009 and 31 March 2010 was carried out. These patients received only mechanical prophylaxis and underwent ultrasound scans of both lower limbs three to seven days post-operation.

The inclusion criteria of this study are:

1. Patients who had undergone elective unilateral TKRs in NUH between 01 March 2009 and 31 March 2010
2. Patients who had undergone bilateral lower limb ultrasound venous Doppler scans on POD three to seven.
3. Patients who used the intermittent pneumatic compression device (IPCD) during the post-operative hospitalisation period
4. Age $\geq$ 16 years old.

Patients below the age of 16 are classified as paediatric patients as per the hospital guidelines of NUH.

The exclusion criteria are:

1. Patients who were known to have other risk factors for DVT:
   1. History of malignancy
   2. Previous lower limb DVT and previous pulmonary embolism
   3. Existing lower limb varicose veins
   4. Congestive heart failure
   5. Pre-existing immobility (wheelchair or bed bound patients)
   6. More than one surgery done
   7. Peripheral vascular disease
2. Incomplete ultrasound examinations:
   1. No ultrasound examination done within the POD three to seven period
   2. Examinations which did not include evaluation of the trifurcation part of the calf veins
   3. Incomplete examinations due to technical difficulties or any other reasons
3. Patients who were on pharmacologic prophylaxis for DVT before or after the surgery
4. Age (< 16 years old)
Patient’s clinical management:

1. All patient has undergone unilateral TKR which was performed by the orthopaedic surgeons who were subspecialising in knee surgery in NUH
2. The Flowtron™ calf IPCDs (Fig. 2) were applied on both calves of all patients immediately and continuously after surgery for the entire postoperative hospital stay
3. All the TKR patients were assisted by physiotherapists to exercise from POD one following the same post-TKR physiotherapy NUH protocol.  

Departmental scanning protocol for lower limb DVT study for post-TKR patients:

A bilateral lower limb DVT study included real time grey scale compression scan in the transverse plane, as well as colour and pulse Doppler scan on longitudinal plane of the entire common femoral vein (CFV), superficial femoral vein (SFV), popliteal vein (POPV), and upper anterior tibial vein (ATV), posterior tibial vein (PTV), peroneal vein (PERV) and muscular veins (MV) of both lower limbs. The veins were compressed with the transducer in the transverse plane in a stepwise fashion consecutively (Fig. 3).

The locations of the DVT were classified according to the nine venous segments on each side:

1. Common femoral vein (CFV)
2. Superficial femoral vein - upper thigh (UPP SFV)
3. Superficial femoral vein - mid thigh (MID SFV)
4. Superficial femoral vein - lower thigh (LOW SFV)
5. Popliteal vein (POPV)
6. Upper anterior tibial vein (UPP ATV)
7. Upper posterior tibial vein (UPP PTV)
8. Upper peroneal vein (UPP PERV)
9. Upper calf muscular vein (UPP MV)

The following clinical data for correlation with the scan findings were obtained:

1. Age
2. Gender
3. Side of TKR surgery
4. Presence/ absence of DVT
5. Side of the DVT
6. Location of the DVT
7. Any prophylaxis given for prevention of DVT, and the type and duration of the prophylaxis.
**Fig 1:** Anterio-posterior and lateral X-ray views of a right knee joint after TKR. Picture Archiving Computer System (PACS), Department of Diagnostic Imaging (DDI), NUH

**Fig. 0**

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Fig 2: Flowtron™ IPCD device used for post TKR patients in NUH. Picture was taken in DDI, NUH.

Fig. 0

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Fig 3: The image demonstrates the uncompressed thrombosed right middle superficial femoral vein. PACS, DDI, NUH.

Fig. 0

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Results

Our study included 253 patients with 506 lower limbs screened (Table 1). Twenty seven (10.7%) patients had DVT. Twenty three (9%) patients had DVT only in the operated limbs, 3 (1.2%) in both limbs, and 1 (0.4%) only in the non-operated limb. One patient developed pulmonary embolism (Table 2). Of the 506 limbs that were scanned, DVT was detected in 30 (5.9%) limbs, 26 (5.1%) of which were the operated limbs and 4 (0.8%) were the non-operated limbs (p < 0.0001). Three limbs had both proximal and distal DVT and 27 limbs had only distal DVT. Therefore, three (0.6%) limbs had proximal DVT and 30 (6%) had distal DVT (p < 0.0001) (Table 3). In another word, three (0.6%) limbs had proximal DVT and 30 (6%) had distal DVT. The three proximal DVT were located in the popliteal veins only.

There were total 41 segments of thrombi detected in the 503 limbs. Eight thrombi were seen in the three limbs that had both proximal and distal DVT. Thirty three thrombi were detected in the 27 limbs that had only isolated distal DVT. No DVT was detected in the common femoral veins, superficial femoral veins and anterior tibial veins (Table 4).

Total five patients received treatment for the DVT. Three patients with both proximal and distal DVT and the other two patients with only distal DVT (one of the patient had PE) had received Clexane (LMWH) treatment ranging from 8 to 28 days. Two patients’ DVT had resolved on their follow up ultrasound scans on the POD 39 and 97 respectively. The other three patients including two patients with proximal DVT and the patient with PE had neither follow up ultrasound scans or further clinical complaints.

Twenty eight thrombi in the remaining 22 patients (24 limbs) who had isolated distal DVT were not treated (Table 5).
Table 1. Patients’ demographics and clinical details

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Number of patients</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (range) Age</td>
<td>Mean: 66 (45 – 90) years</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>65</td>
<td>26</td>
</tr>
<tr>
<td>Female</td>
<td>188</td>
<td>74</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>190</td>
<td>75.1</td>
</tr>
<tr>
<td>Malay</td>
<td>22</td>
<td>8.7</td>
</tr>
<tr>
<td>Indian</td>
<td>32</td>
<td>12.6</td>
</tr>
<tr>
<td>Sikh</td>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>Others</td>
<td>2</td>
<td>2.8</td>
</tr>
<tr>
<td>Clinical History</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>249</td>
<td>98.4</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>Side of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right TKR</td>
<td>145</td>
<td>57</td>
</tr>
<tr>
<td>Left TKR</td>
<td>108</td>
<td>43</td>
</tr>
<tr>
<td>Mean (range) POD of ultrasound examination</td>
<td>Mean: POD 4 ± 1 (POD 3 – 7)</td>
<td></td>
</tr>
<tr>
<td>Mean duration of mechanical prophylaxis (IPCD)</td>
<td>Mean: 4 ± 1 (3 – 7) days</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 0

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<table>
<thead>
<tr>
<th>Description</th>
<th>Number of patients</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with DVT (overall)</td>
<td>27</td>
<td>10.7</td>
</tr>
<tr>
<td>Patient with operated limb DVT</td>
<td>26</td>
<td>10.2</td>
</tr>
<tr>
<td>Patients with both operated and non-operated limb DVT</td>
<td>3</td>
<td>1.2</td>
</tr>
<tr>
<td>Patient with only non-operated limb DVT</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Patients with proximal DVT</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td>Patients with distal DVT</td>
<td>27</td>
<td>10.7</td>
</tr>
<tr>
<td>Patients with both proximal and distal DVT</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td>Patients with isolated distal DVT</td>
<td>24</td>
<td>9.5</td>
</tr>
<tr>
<td>Patient with PE</td>
<td>1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

**Fig. 0**

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Table 3. Incidence and distribution of ultrasound confirmed postoperative deep vein thrombosis in the 506 limbs

<table>
<thead>
<tr>
<th></th>
<th>Number of limbs</th>
<th>Percentage (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVT (overall)</td>
<td>30</td>
<td>5.9</td>
<td>Nil</td>
</tr>
<tr>
<td>Operated limbs with DVT</td>
<td>26</td>
<td>5.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Non-operated limbs with DVT</td>
<td>4</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Limbs with proximal DVT</td>
<td>3</td>
<td>0.6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Limbs with distal DVT</td>
<td>30</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Limbs with isolated distal DVT</td>
<td>27</td>
<td>5.4</td>
<td>Nil</td>
</tr>
<tr>
<td>Limbs with both proximal and distal DVT</td>
<td>3</td>
<td>0.6</td>
<td>Nil</td>
</tr>
</tbody>
</table>

Fig. 0

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Table 4. The distribution of the thrombi

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage (%)</th>
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<tbody>
<tr>
<td>Total thrombi</td>
<td>41</td>
<td>100</td>
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<tr>
<td>CFV</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SFV</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>POPV</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>PTV</td>
<td>11</td>
<td>27</td>
</tr>
<tr>
<td><strong>PERV</strong></td>
<td>14</td>
<td><strong>34</strong></td>
</tr>
<tr>
<td>ATV</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MV</td>
<td>11</td>
<td>27</td>
</tr>
</tbody>
</table>

Fig. 0

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Table 5. The outcome of untreated distal DVT

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total untreated distal thrombi</td>
<td>28</td>
<td>100</td>
</tr>
<tr>
<td>Resolved distal thrombi</td>
<td>15</td>
<td>54</td>
</tr>
<tr>
<td>Remain unchanged distal thrombi</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Distal thrombi without any follow up ultrasound scan</td>
<td>9</td>
<td>32</td>
</tr>
</tbody>
</table>
Conclusion

It has been suggested that the prevalence of post-TKR DVT in Western patients is higher than that in Asian patients. The reported prevalence of DVT after TKR without any prophylaxis was between 40 and 84 percent in Western populations. In Asian TKR patients, it was reported as between 22 and 43 percent. With the use of recommended prophylaxis, the prevalence of DVT after TKR in Western patients was approximately 22 to 50 %, and less than 10% in the Asian patients. The incidence of DVT in our study is relatively comparable to the data of the other published studies on Asian population. It is also much lower than the incidence in the Western populations.

Our study also found that the incidence of DVT in the non-operated limbs was significantly lower than the operated limbs (0.8% compared to 5.1%, p < 0.0001) following unilateral TKRs. The four cases (0.8%) of non-operated limb DVT were detected in the calves, and anticoagulation treatment was not indicated as per our institutional protocol. Most of the isolated distal DVT resolved spontaneously.

These findings suggest that it may be necessary to re-evaluate the current DVT screening protocol for post TKR patients. Post-operative ultrasound scan should only be performed on the operated lower limbs for all Singaporean TKR patients. Nevertheless, a prospective inter-institutional study of larger sample size, with systematic follow up plans should be carried out to further consolidate this evidence.
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