THE SIGNIFICANCE OF CALF THROMBI AFTER TOTAL KNEE ARTHROPLASTY

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We reviewed the records of 1257 patients having 1625 total knee arthroplasties; all had pre-operative and postoperative perfusion lung scans and postoperative venograms which were classified as showing no thrombi, calf thrombi or proximal thrombi.

Patients with calf thrombi were found to have a significantly greater risk for both symptomatic and asymptomatic pulmonary embolism compared with patients with no venographic thrombi. There were positive lung scans in 6.9% of patients with calf thrombi compared with 2.0% of patients with negative venograms (p < 0.001). Symptomatic pulmonary embolism occurred in 1.6% of patients with calf thrombi compared with 0.2% of patients with negative venograms (p = 0.034). The risk of pulmonary embolism was not significantly different between patients with treated proximal thrombi, and those with calf thrombi.

Patients who develop deep-vein thrombosis despite prophylaxis are at increased risk for pulmonary embolism; these patients should receive treatment, or undergo follow-up studies to detect proximal propagation.

Thrombo-embolic disease is a potentially serious complication of total knee arthroplasty. Routine postoperative venography reveals an incidence of 40% to 60% of isolated calf thrombi, and of 3% to 20% of proximal thrombi (Cohen et al 1973; McKenna et al 1976; Hull et al 1979; McKenna, Galante and Bachmann 1980; Stulberg et al 1984; Stringer et al 1989; Francis et al 1990; Haas et al 1990; Maynard, Sculco and Ghelman 1991). Most authors agree that patients with proximal thrombi are at the greatest risk for symptomatic pulmonary embolism (Kakkar et al 1969; Moser and LeMoine 1981; Lotke, Wong and Ecker 1986; Giachino 1988), but the clinical significance of calf thrombi is disputed. Some authors consider that asymptomatic calf thrombi pose little or no increased risk (Moser and LeMoine 1981; Lotke 1989), but others report that patients with calf thrombi have an increased risk of asymptomatic pulmonary embolism: 6% to 23% of calf thrombi have been shown to propagate to proximal veins (Kakkar et al 1969; Douoss 1976; Lotke et al 1986).

The relationship between venous thrombosis and symptomatic pulmonary embolism has not previously been studied in a large group of patients with total knee arthroplasty. We examined the records of 1257 patients who underwent 1625 total knee arthroplasties, to compare the risk of pulmonary embolism in patients with calf thrombi and in patients with no evidence of thrombosis.

PATIENTS AND METHODS

We reviewed all primary total knee arthroplasties performed by the Knee Service at the Hospital for Special Surgery between September 1974 and December 1986. We included all the patients having unilateral or bilateral arthroplasty who had completed a standard thrombo-embolic surveillance protocol. For patients who had staged bilateral procedures only the first procedure was included.

A cemented condylar-type prosthesis was used, and aspirin 650 mg twice daily was routinely given as prophylaxis, beginning before operation. Venography was performed on the fourth, fifth or sixth postoperative
day, using the technique described by Rabinov and Paulin (1972), except that a tourniquet was used to occlude the superficial veins. Thrombi were classified according to their most proximal location. We considered that popliteal, femoral and iliac thrombi were evidence of proximal deep-vein thrombosis.

We performed a baseline perfusion lung scan pre-operatively which was repeated on the fifth, sixth or seventh postoperative day. Lung scans were considered to be positive if the postoperative scan showed a segmental or larger defect not present pre-operatively.

Patients were considered to have had symptomatic pulmonary embolism if objective signs and symptoms were confirmed by lung scan or pulmonary angiography.

Thrombosis of the calf veins, either symptomatic or asymptomatic, was treated with warfarin adjusting the daily dosage to maintain the prothrombin time between 1.3 and 1.6 times the control value. Asymptomatic patients found to have proximal thrombi or positive lung scans were also treated with warfarin. Patients with large or symptomatic proximal thrombi, or symptomatic study. The exclusion of 316 patients was due to failure to complete the full protocol or to insufficient documentation. Unilateral arthroplasty was performed in 889 patients, and 368 had one-stage bilateral arthroplasties.

RESULTS

Of the 1257 patients who had had total knee arthroplasty, 759 (60.4%) were found to have thrombosis; 655 (52.1%) had calf-vein thrombosis and 104 (8.3%) had thrombosis of the proximal veins. Patients having one-stage bilateral arthroplasty were found to be at increased risk of both proximal and distal thrombosis (Table I).

There were positive lung scans in 59 patients (4.7%), and symptomatic pulmonary emboli occurred in 14 patients (1.1%), but there were no fatal pulmonary emboli during the study period. Patients who had had bilateral arthroplasty were also found to have an increased risk of positive lung scans and symptomatic pulmonary emboli (Table I).

Patients with calf thrombi were seen to have a

Table I. The incidence of thrombo-embolic complications after total knee arthroplasty (number, percentage)

<table>
<thead>
<tr>
<th></th>
<th>Venographic thrombus</th>
<th>Proximal</th>
<th>Positive lung scan</th>
<th>Symptomatic pulmonary embolus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Calf</td>
<td>Proximal</td>
<td></td>
</tr>
<tr>
<td>Unilateral (n = 889)</td>
<td>385</td>
<td>433.3</td>
<td>434.48.8</td>
<td>70 7.9</td>
</tr>
<tr>
<td>Bilateral (n = 368)</td>
<td>113</td>
<td>30.7</td>
<td>221 60.1</td>
<td>34 9.2</td>
</tr>
<tr>
<td>Total (n = 1257)</td>
<td>498</td>
<td>39.6</td>
<td>655 52.1</td>
<td>104 8.3</td>
</tr>
</tbody>
</table>
venogram and lung scan were negative, but the patient
developed prostatic obstruction, and on the twelfth
postoperative day underwent a suprapubic cystostomy.
Ten days after this operation, he developed shortness of
breath and a positive lung scan confirmed the diagnosis
of pulmonary embolism.

Patients with calf or proximal thrombi were found
to have similar rates of positive lung scans and symptom-
atic pulmonary embolism. Of 104 patients with prox-
imal thrombi, five (4.8%) had positive lung scans and two
(1.9%) had symptomatic pulmonary embolism.

DISCUSSION

Deep-vein thrombosis is common after total knee
arthroplasty. Despite prophylaxis, over 52% of our
patients who underwent total knee arthroplasty between
1974 and 1986 developed calf thrombi. Proximal thrombi
were noted much less frequently, in 8.3%. These rates are
similar to those reported in other studies.

To develop an effective management protocol for
thrombo-embolic disease, the natural history of calf
thrombi must be defined. Kakkar et al (1969) used
venography and serial fibrinogen imaging to evaluate the
progress of calf thrombi in a group of postoperative
patients. They found that 23% of calf thrombi propagated
to the proximal veins. Douoss (1976) performed a similar
evaluation and found a 5.6% propagation rate. Maynard
et al (1991) carried out serial venography in patients who
had undergone total knee arthroplasty and found that
12% of the calf thrombi which were identified within one
day of surgery propagated to the proximal veins by the
fifth postoperative day. Asymptomatic pulmonary em-
bolism has been shown to occur more frequently in
patients with deep-vein thrombosis: Lotke et al (1986)
reported that the incidence of asymptomatic embolism
was three times greater for patients with deep-vein
thrombosis compared with those with negative ve-
ogram.

Our study indicates that patients with calf thrombi
have a significantly increased risk for both asymptomatic
and symptomatic pulmonary emboli compared with
those without thrombosis. Previous studies have shown
that proximal thrombi represent the greatest risk for
symptomatic and fatal pulmonary emboli (Kakkar et al
1969; Moser and LeMoine 1981; Lotke et al 1986;
Giachino 1988). In our series, the rate of symptomatic
pulmonary embolism was slightly higher in patients with
proximal thrombi than in those with calf thrombi, but
the difference was not found to be significant. This may
reflect the fact that patients with proximal thrombi were
more frequently treated with intravenous heparin.

The first goal of the management of thrombo-
embolic disease is the prevention of thrombosis. We used
aspirin 650 mg twice daily as the primary prophylactic
agent. This treatment, combined with early postoperative
diagnosis by venography and treatment with warfarin,
proved effective in preventing death but other prophylac-
tic methods are more successful in preventing the
formation of thrombi. There is no ideal method but the
use of pneumatic compression boots, antithrombin III
with heparin, and low-molecular-weight heparin have
been shown to reduce the incidence of deep-vein
thrombosis.

The management of patients who have developed
calf thrombosis is difficult. It may have been possible to
reduce the incidence of pulmonary embolism by treating
calf thrombosis with intravenous heparin, but, in the
early postoperative period, heparin has been shown to
produce complications in over 45% of cases (Patterson,
Marchand and Ranawat 1989). We therefore feel that
intravenous heparin therapy is not indicated for asym-
omatic calf thrombi (Giachino 1988). Low-dose warfarin
therapy has been shown to reduce embolisation after
total hip arthroplasty; it may have been effective in
limiting the number of symptomatic and fatal pulmonary
embolii in our patients (Paiement et al 1986; Amstutz et
al 1989). It is also associated with a low rate of
complications (Hull et al 1982; Paiement et al 1986).

Duplex ultrasound scans have recently been shown
to be sensitive in detecting proximal thrombi (Froehlick
are non-invasive and may be repeated several times to
determine proximal propagation of calf thrombi. Sym-
ptomatic and fatal pulmonary emboli after total knee
arthroplasty most probably occur as a result of propaga-
tion and subsequent embolisation, and an acceptable
management may be the use of an effective prophylactic
method followed by serial duplex ultrasound scanning.
Further study is needed both to define the use of
ultrasound scanning after total knee arthroplasty, and to
evaluate better the modality of treatment.

In addition to location, the size of the thrombus may
also be important. Our study did not examine the
relationship between size and pulmonary embolism, but
other authors have shown that thrombi greater than
5 mm are more likely to propagate and embolise (Kakkar
et al 1969; Lotke et al 1986).

Conclusions. We feel that all patients undergoing total
knee arthroplasty should receive an effective prophylactic
agent. Patients who develop deep-vein thrombosis
despite such prophylaxis are at increased risk for
pulmonary embolism and should either receive treatment,
or undergo follow-up studies to detect propagation into
the proximal veins.

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