Preoperative or Postoperative Start of Prophylaxis for Venous Thromboembolism With Low-Molecular-Weight Heparin in Elective Hip Surgery?

Niklaus Strebel, MD; Martin Prins, MD; Giancarlo Agnelli, MD; Harry R. Büller, MD

Background: Prophylaxis of venous thromboembolism with low-molecular-weight heparins in patients undergoing major orthopedic surgery is currently initiated according to at least 3 different regimens. In Europe, traditionally, prophylaxis is started 12 hours before surgery, whereas in North America it is initiated 12 to 48 hours postoperatively. The third regimen (perioperative) begins prophylaxis either earlier than 12 hours before or 12 hours after surgery. Unfortunately, the optimal regimen is uncertain because direct comparisons among these regimens with sufficiently large sample sizes are not available.

Objective: To assess, in a systematic review, the relative efficacy and safety of the 3 low-molecular-weight heparin regimens used to prevent thrombosis after total hip replacement. The incidence of postoperative thrombosis detected by contrast venography was used as the measure of efficacy and the rate of major bleeding was used as the measure of safety.

Methods: We pooled the results of all published studies, which met the following criteria: (1) inclusion of at least 1 arm of the study of a dose of low-molecular-weight heparin that is approved for both preoperative and postoperative initiation of prophylaxis; (2) the use of mandatory bilateral contrast venography, performed between days 6 and 15 postoperatively; (3) thromboprophylaxis continued until venography; (4) independent reading of venograms; and (5) assessment of clinically overt major bleeding by predefined criteria. Articles were excluded if no separate data could be obtained for patients undergoing elective hip surgery (in case of patient mix), or if they were reported more than once.

Results: In the 1926 patients who used a preoperative regimen, the incidence of postoperative deep vein thrombosis was 19.2% (95% confidence interval [CI], 17%-21%). In the cohort of 925 patients who received a perioperative regimen, the rate of deep vein thrombosis was 12.4% (95% CI, 10%-14%), whereas in the group of 694 patients who received a postoperative regimen, it was 14.4% (95% CI, 12%-17%). The rate of major bleeding was 1.4% (95% CI, 1%-2%) in the preoperative group, 6.3% (95% CI, 5%-7%) in the perioperative group, and 2.5% (95% CI, 1%-3%) in the postoperative group.

Conclusions: We find no convincing evidence that starting prophylaxis preoperatively is associated with a lower incidence of venous thromboembolism than starting postoperatively. Perioperative regimens may lower the risk of postoperative thrombosis, but if so, this positive effect is offset by an increase in postoperative major bleeding.

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preoperatively or postoperatively. Relying on the same dose of LMWH in pa-
tients, we limited the analysis to stud-
ies using the same dose of LMWH
prophylaxis prior to surgery is ad-
vantageous. To allow a fair compari-
sion, we limited the analysis to stud-
ies using the same dose of LMWH
preoperatively or postoperatively.

METHODS

SEARCH STRATEGY

We searched for randomized con-
trolled trials reporting on the inci-
dence of venous thrombosis and
bleeding in patients undergoing elec-
tive hip surgery with LMWH pro-
phylaxis. Studies were identified
through MEDLINE (Medical Sub-
ject Headings of the National Li-
brary of Medicine keywords: hip
prosthesis, venous thrombosis, and
low molecular weight heparins). The
reference lists of the identified ar-
ticles were then manually checked
for additional publications.

ELIGIBILITY CRITERIA FOR STUDIES

Included in the systematic review
were all trials that met the follow-
ing criteria: (1) at least 1 arm of the
study should have included a cur-
cently recommended dose of LMWH
that is approved for both preopera-
tive and postoperative initiation; (2)
mandatory bilateral contrast venog-
raphy, performed between days 6
and 15 postoperatively; (3) continu-
ation of thromboprophylaxis until
venography; (4) independent read-
ing of venogram; and (5) assess-
ment of clinically overt major bleed-
ing by predefined criteria. Articles
were excluded if separate data could
not be obtained for patients under-
going elective hip surgery (in case
of patient mix), or if they were re-
ported more than once.

CLASSIFICATION OF THE
PROPHYLACTIC REGIMENS

Studies were divided into 3 groups
according to the time of the initia-
tion of prophylaxis. Preoperative
regimens had to start prophylaxis at
least 12 hours before the opera-
tion, usually defined as the evening
before surgery. The perioperative
group included all trials that began
prophylaxis 2 hours before or up to
4 hours after surgery. In the group
using postoperative regimens, pro-
phylaxis was started 12 to 48 hours
after the surgical procedure.

OUTCOMES

Efficacy was assessed by the inci-
dence of venographically docu-
mented DVT between 6 and 15 days
postoperatively, or documented
symptomatic DVT that occurred ear-
ier. Safety was assessed by docu-
menting the number of major bleed-
ing episodes. No attempt was made
to compare the frequency of minor
bleeding because of the large varia-
tion in definitions used.

STATISTICAL ANALYSIS

The incidences of DVT and major
bleeding were pooled for trials in
each of the 3 regimens. Pooling was
weighted based on sample size, and
95% confidence intervals (CIs) were
calculated.

LITERATURE SEARCH
AND TRIAL SELECTION

Of the 49 identified trials, 14 were
not eligible (4 trials used doses of
LMWH that are currently not rec-
ommended for preoperative and
postoperative use;4-11) venography
was not mandatory in 5 trials;12,13 in
3 other studies, the time of venog-
raphy was outside the 6- to 15-day
postoperative window;10,12,14 in 1 trial,
venography was only unilateral;13,
and in 1 study, bleeding was not sys-
tematically documented.14

Of the 35 potentially eligible
studies, another 21 had to be ex-
cluded. Of these, 13 were pub-
lished more than once.15-27 6 stud-
ies investigated patients with hip
and/or knee arthroplasty where the
data could not be analyzed separ-
ately.28-33 2 studies included pa-
tients with hip fractures in our
pool.34,35 Thus, a total of 14 trials that reported on
19 cohorts of patients were in-
cluded.36-49

INCIDENCE OF
POSTOPERATIVE DVT

Eleven trials were included for anal-
sis of efficacy of the preoperative
regimens; 9 with enoxaparin so-
dium, 1 with dalteparin sodium, and
1 with tinzaparin sodium (Table 1).
Three studies were included for the
perioperative regimen, 1 with enoxa-
parin and 2 with dalteparin, whereas
4 studies used a postoperative regi-
men, all using enoxaparin.

The overall incidence of DVT, as
well as that for proximal and dis-
tal DVT separately, for the study co-
HORTS is presented in Table 2.

In the preoperative group of
trials, a total of 1926 patients
(Table 3) were enrolled with an
incidence of thrombosis of 19.2%
(95% CI, 17%-21%). The perioper-
ative group included 925 patients
(Table 3) and showed an incidence
of postoperative DVT of 12.4%
(95% CI, 10%-14%). In the postopera-
tive group, a total of 694 pa-
tients were studied. The incidence
of postoperative DVT was 14.4%
(95% CI, 12%-17%). The inci-
dence of proximal DVT was 7.6% for
the preoperative group, 2% for the
perioperative group, and 5% for the
postoperative group. The majority of
patients in both the preoperative and
postoperative groups were treated
with enoxaparin. If we limit the
analysis to this LMWH only, the
incidence of thrombosis for the pre-
operative group is 18% (95% CI,
16%-20%) and 14.4% (95% CI, 12%-17%)
for the postoperative group
(Table 2).

INCIDENCE OF MAJOR
BLEEDING

The incidence of major bleeding in
each of the cohorts is summarized in
Table 2. In the preoperative group
(2785 patients), the incidence of ma-
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major bleeding was 1.4% (95% CI, 1%-2%), in the perioperative group (1315 patients), the incidence was 6.3% (95% CI, 5%-7%), and in the postoperative group (751 patients) it was 2.5% (95% CI, 1%-3%) (Table 3).

COMMENT

The main conclusion of our pooled analysis across different studies with a preoperative, perioperative, or postoperative initiation of thromboprophylaxis with LMWH is that there is no convincing evidence that starting prophylaxis approximately 12 hours before surgery is more effective in preventing venography-detected DVT than starting 12 to 48 hours postoperatively (total DVT rate preoperatively and postoperatively; 19.2% [95% CI, 17%-21%] and 14.4% [95% CI, 12%-17%], respectively). Similarly, there is no evidence that the postoperative regimen is safer than the preoperative regimen. In contrast, when thromboprophylaxis is started either soon before (2 hours) or after (4 hours) surgery, even with reduced doses, there is a trend for a lower risk of venous thrombosis, but this benefit appears to be counterbalanced by a marked increase in the risk of major bleeding in comparison with the 2 other regimens (major bleeding rate was 6.3% [95% CI, 5%-7%] in the perioperative group compared with 1.4% [95% CI, 1%-2%] and 2.5% [95% CI, 1%-3%] in the preoperative and postoperative groups, respectively).

Since the across-study comparisons used in our analysis have obvious limitations, it is important to compare our findings with those of the few studies that have compared several regimens directly, as well as with an earlier overview on this topic. The only published study that compared a 12-hour preoperative regimen with a perioperative regimen (1 hour after induction of anesthesia) and a postoperative regimen (12 hours) was performed by Planes et al—they found no statistical difference in efficacy. This study was performed to evaluate the safety of combining LMWH with various types of anesthesia and only about 60 patients were included in each of the 3 groups.

Recently, Hull and colleagues compared an early preoperative regimen (2 hours preoperatively) with an early postoperative regimen (4 hours postoperatively) with reduced doses of an LMWH (dalteparin, 2500 IU, 2 hours preoperatively, 4 hours postoperatively, respectively, followed by 5000 IU/d). There were about 300 patients in each group. The incidence of postoperative thrombosis was 11% in the group that started prophylaxis 2 hours preoperatively and 13% in the 4 hours postoperative group. This relatively low incidence of thrombosis is offset by a relatively high rate of major bleeding of 8.8% in the early preoperative group and 6.8% in the early postoperative group. The rates of bleeding in both of these perioperative groups are higher than those observed in our pooled postoperative and preoperative groups as well as in the 2 other perioperative groups reported by Planes et al and Fran-

### Table 1. Characteristics of the Studies Included in the Overview

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Source</th>
<th>No. of Patients</th>
<th>No. With Evaluable Venogram</th>
<th>Days of Venogram</th>
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<tbody>
<tr>
<td><strong>Preoperative Regimens</strong></td>
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<tr>
<td>Enoxaparin</td>
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<tr>
<td>40 mg, first dose 12 h preoperatively</td>
<td>Borris et al, 1991</td>
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<td>108</td>
<td>7-11</td>
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<td>1036</td>
<td>785</td>
<td>8-12</td>
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<td>39</td>
<td>32</td>
<td>8-12</td>
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<tr>
<td>40 mg, first dose 12 h preoperatively</td>
<td>Planes et al, 1988</td>
<td>124</td>
<td>120</td>
<td>12-15</td>
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<tr>
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<td>50</td>
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<tr>
<td>40 mg, first dose 12 h preoperatively</td>
<td>Planes et al, 1990</td>
<td>59</td>
<td>57</td>
<td>12-15</td>
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<td>Planes et al, 1993</td>
<td>221</td>
<td>209</td>
<td>10-13</td>
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<td>248</td>
<td>219</td>
<td>12-14</td>
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<td><strong>Perioperative Regimens</strong></td>
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<tr>
<td>Enoxaparin</td>
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<tr>
<td>20 mg, 1 h preoperatively, 40 mg/d postoperatively</td>
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<td>40 mg, 12-48 h postoperatively</td>
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<tr>
<td>40 mg, 12-48 h postoperatively</td>
<td>Samama et al, 1997</td>
<td>85</td>
<td>78</td>
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</table>
Comparisons of major bleeding in our analysis with the study reported by Hull et al. are limited both because they are indirect and because they did not use identical definitions of major bleeding. Our conclusions also differ from those reported in a meta-analysis published in 1999 in which the efficacy and safety of preoperative and postoperative initiation of a single LMWH was compared. This ear-

<table>
<thead>
<tr>
<th>Drugs and Source</th>
<th>All DVT, No./Total No. (%)</th>
<th>Proximal DVT, No. (%)</th>
<th>Distal DVT, No. (%)</th>
<th>Major Bleeding, No./Total No. (%)</th>
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<td><strong>Preoperative Regimens</strong></td>
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<td>Planes et al.42 1988</td>
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<td>5 (3)</td>
<td>1/221 (1)</td>
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<td>Planes et al.47 1999</td>
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<td>4/248 (2)</td>
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<tr>
<td>Total</td>
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<td>119</td>
<td>183 (11)</td>
<td>29/1962 (1)</td>
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<td>Dalteparin</td>
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<td>12 (19)</td>
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<td>Planes et al.49 1999</td>
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<td>4 (7)</td>
<td>3 (5)</td>
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<td>6/271 (2)</td>
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<td>Hull et al.50 2000†</td>
<td>36/337 (11)</td>
<td>3 (1)</td>
<td>33 (10)</td>
<td>44/496 (9)</td>
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<td>Hull et al.50 2000‡</td>
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<td>3 (1)</td>
<td>41 (12)</td>
<td>32/487 (7)</td>
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<tr>
<td>Total</td>
<td>108/855 (12)</td>
<td>16 (2)</td>
<td>92 (19)</td>
<td>19/751 (3)</td>
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<td><strong>Postoperative Regimens</strong></td>
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<tr>
<td>Colwell and Spiro.51 1995</td>
<td>57/402 (14)</td>
<td>17 (4)</td>
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<td>9 (6)</td>
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<td>Samama et al.53 1997</td>
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<td>8 (10)</td>
<td>1/85 (1)</td>
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<tr>
<td>Total</td>
<td>100/694 (14)</td>
<td>33 (5)</td>
<td>67 (9)</td>
<td>19/751 (3)</td>
</tr>
</tbody>
</table>

*DVT indicates deep vein thrombosis.
†2500 IU, first dose 2 hours preoperatively and 2500 IU evening after surgery, afterwards daily 5000 IU.
‡2500 IU, 4 hours postoperatively followed by 5000 IU/d.

| Table 3. Pooled Analysis of the Frequencies of Deep Vein Thrombosis and Major Bleeding Episodes of the 3 Low-Molecular-Weight Heparin Regimens |
|------------------|---------------------------|----------------------|-------------------|----------------------------------|
| | Preoperatively† | Perioperatively‡ | Postoperatively§ |
| **All DVT** | | | |
| No./Total No. (%) | 369/1926 (19) | 115/925 (12) | 100/694 (14) |
| 95% CI | 17-21 | 10-14 | 12-17 |
| **Proximal DVT** | | | |
| No./Total No. (%) | 147/1926 (8) | 20/925 (2) | 33/694 (5) |
| 95% CI | 6-8 | 1-3 | 4-7 |
| **Distal DVT** | | | |
| No./Total No. (%) | 224/1926 (11) | 95/925 (10) | 67/694 (10) |
| 95% CI | 10-12 | 8-12 | 7-11 |
| **Major bleeding episodes** | | | |
| No./Total No. (%) | 32/2275 (1) | 83/1315 (6) | 19/751 (3) |
| 95% CI | 1-2 | 5-7 | 1-3 |

*DVT indicates deep vein thrombosis; CI, confidence interval.
†Twelve hours preoperatively.
‡Two hours preoperatively until 4 hours postoperatively.
§Twelve to 48 hours postoperatively.
lier meta-analysis concluded that the preoperative regimen was more effective and as safe as the postoperative regimen. The major differences between the 2 meta-analyses are that we included more studies, allowed the inclusion of different LMWHs, and did not exclude the large study by Eriksson et al. We limited our analysis to one and the same dose regimen used preoperatively and postoperatively so as not to introduce bias due to larger doses used postoperatively. If, however, we limit the analysis to the same LMWH that was studied in the other meta-analysis, our overall conclusions do not change.

The optimal timing for initiating postoperative thromboprophylaxis remains controversial. For example, the recent pentasaccharide study initiated prophylaxis subcu-

taneously 6 hours after surgery with a major reduction in the rate of venous thrombosis without an apparent increase in clinically important bleeding. In another dose-finding study with a compound directed against the tissue factor VIIa complex, prophylaxis using the subcu-

taneous route was started within 1 hour after surgery, without an apparent increase in major bleeding.

It is likely that with the increasing use of regional anesthe-

sia, the preoperative initiation of thromboprophylaxis will gradually disappear and that future research will be directed toward the optimal timing of postoperative prophylaxis. It is also possible that the optimal timing might differ depending on the mechanism of action of the agent in question.

We conclude that for the currently used LMWHs, there is no convin-

cing evidence that starting prophylaxis 12 hours preoperatively is associated with a lower risk of venous thrombosis than when prophylaxis is started 12 to 24 hours postoperatively. Perioperative thromboprophylactic regimens require further investigation before their role can be defined.

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vla.nl).

REFERENCES

6. Kovacs MJ, Weir K, MacKinnon K, Kenney M, Brien WF, Cruickshank MK. Body weight does not predict for anti-Xa levels after fixed dose prophyla-

9. Warwick D, Bannister GC, Glew D, et al. Periop-

erative low-molecular-weight heparin: is it effec-


discharge prophylactic management of the or-

thopedic patient with low-molecular-weight hepa-


molecular-weight heparin (enoxaparin) as pro-

12. Lassen MR, Borris LC, Anderson BS, et al. Efficacy and safety of prolonged thromboprophylaxis with a low molecular weight heparin (daltepa-

13. Warwick D, Harrison J, Glew D, Mitchellmore A, Peters TJ, Donovan J. Comparison of the use of a foot pump with the use of low-molecular-

weight heparin for the prevention of deep-vein thrombosis after total hip replacement: a pro-


longed thromboprophylaxis following hip replace-

ment surgery—results of a double-blind, pro-

15. Bara L, Planes A, Samama MM. Occurrence of thrombosis and haemorrhage, relationship with anti-Xa, anti-?a activities, and D-dimer plasma lev-

16. Colwell CW Jr, Sprio TE, Trowbridge AA, et al. for the Enoxaparin Clinical Trial Group. Use of enoxa-

parin, a low-molecular-weight heparin, and un-

fractionated heparin for the prevention of deep ve-

17. Dahl OE, Aspelin T, Arnesen H, et al. Increased activation of coagulation and formation of late deep venous thrombosis following discontinuation of thromboprophylaxis after hip replacement sur-


molecular-weight heparin prophylaxis using dalteparin extended out-of-hospital vs in-

hospital warfarin/out-of-hospital placebo in hip ar-

throplasty patients: a double-blind, randomized compar-

19. Planes A, Vochelle N. The post-hospital dis-


spective randomised double-blind placebo-

21. Planes A, Vochelle N, Darmon JY, Fagola M, Bel-

lau M, Huet Y. Risk of deep-venous thrombosis after hospital discharge in patients having under-

gone total hip replacement: double-blind ran-

domised comparison of enoxaparin versus pla-

22. Planes A, Vochelle N, Fagola M, Bellau M, for the Reviparin Study Group. Comparison of two low-
molecular-weight heparins for the prevention of postoperative venous thromboembolism after elec-


blind randomized comparative study of enoxapa-

25. Planes A, Vochelle N, Mazas F, et al. Use of enoxaparine in preventing deep vein thrombo-

sis following total hip prosthesis: randomized mul-

ticenter prospective trial [in French]. Rev Chir Or-


