Introduction

A comprehensive knowledge of novel anticoagulants is an important part of current neurosurgical practice. While warfarin, heparin and its low molecular weight derivative, enoxaparin, have formed the mainstream of treatment for atrial fibrillation, valvular heart disease and the prevention of venous thromboembolism for over 30 years,[1] new agents have recently been approved that promise to revolutionize the treatment of these conditions. There are compelling medical reasons driving the adoption of these agents and they will have an important impact on neurosurgical practice. Here we review the risks and benefits of a novel direct thrombin inhibitor, dabigatran etexilate and consider its implications for neurosurgeons.

The benefits of direct thrombin inhibition

Despite the fact that heparin and warfarin are inexpensive and easy to reverse, they suffer from several well known limitations.[2,3] These include parenteral administration for heparin, slow onset and offset of action for warfarin and variable pharmacokinetics for both agents, necessitating frequent monitoring with serum coagulation studies.[1,2] These tests are inconvenient for patients and expensive for health care systems.

Dabigatran etexilate is a novel oral anticoagulant with stable pharmacokinetics—unlike warfarin, it does not require routine blood tests to monitor its anticoagulative effect.[1] There is no need for dose titration. While drug interactions do affect dabigatran's absorption and metabolism, co-administration with other agents is greatly simplified when compared to warfarin as it is not metabolized by cytochrome p450 isoenzymes. Dabigatran is a direct thrombin inhibitor with a terminal half life of eight hours for a single dose and...
12 to 14 hours for multiple doses. Dabigatran is renally excreted and its half life can exceed 24 hours in patients with renal impairment.

Dabigatran has been approved in Europe, the United States, and Canada for the prevention of stroke in patients with non-valvular atrial fibrillation. In these patients, typical dosing is 150 mg per oral (PO) twice daily. In patients with reduced creatinine clearance, the dose is reduced to 75 mg PO twice daily. Patients should cease warfarin prior to conversion to dabigatran and dabigatran should only be started when the international normalized ratio (INR) is below 2.0.

In Europe, dabigatran has further been approved for use in the prevention of post-operative thromboembolic complications in patients undergoing hip or knee replacement surgery. In these patients, typical dosing includes one 110 mg oral dose taken one to four hours after surgery followed by 110 mg PO twice daily for 28 to 35 days in cases of hip replacement and for 10 days in cases of knee replacement. When converting from heparin or enoxaparin for venous thromboembolic prophylaxis, dabigatran should be started up to two hours prior to the time of the next dose of parenteral anticoagulant was to be administered. Importantly, dabigatran has not been approved for use as thromboembolic prophylaxis in settings other than orthopedic surgery.

In patients with normal renal function dabigatran should be stopped two to four days prior to surgery in order for serum levels to fall below five to ten percent. Table 1 compares the pharmacokinetics of dabigatran with other commonly uses anticoagulants.

**Surgical Pitfalls of Dabigatran**

While dabigatran presents significant medical advantages, there are important surgical pitfalls. There is no specific reversal agent for dabigatran. Known reversal options include activated charcoal (within one to two hours of intake) and renal dialysis. When dialysis is not possible – for example, in surgical emergencies – recombinant factor VIIa, prothrombin complex and/or concentrates of coagulation factors II, IX, or X may be considered, but their use has not been evaluated in clinical trials. Protamine sulfate and vitamin K are not expected to affect the activity of dabigatran. Platelet concentrates can be given when thrombocytopenia is also present or long-acting antiplatelet agents have been used but these will not inactivate dabigatran’s anti-thrombin properties.

In addition, there is no readily available assay for assessing the degree of anticoagulation with dabigatran. Conventional markers of serum coagulability are typically normal in patients taking dabigatran. The most sensitive test for assessing its activity is ecarin clotting time and this assay may not be available in most hospitals. It is not currently available on-site at our large tertiary center in Sydney, Australia.

Garber et al. recently presented an alarming case of mortality related to dabigatran use that highlights the importance of neurological issues related to this novel agent. An 82-year-old man presented to hospital after sustaining a minor fall. He was recently commenced on dabigatran 150 mg PO twice daily for atrial fibrillation. At presentation, his Glasgow Coma Scale (GCS) was 15 with no neurological deficits. The initial non-contrast computed tomography (CT) scan revealed a small intraparenchymal hemorrhage and associated subdural hemorrhage with no mass effect. Despite this reassuring finding, he experienced a rapid neurological decline to a GCS of 6 over the course of the next few hours. Recombinant factor VII was given without effect. Repeat CT brain showed a catastrophic extension of the intraparenchymal hemorrhage with significant mass effect. In light of a very poor neurological prognosis, the patient was palliated and passed away shortly thereafter.

This report casts in sharp relief the dangers of dabigatran in the AF population. These patients are typically elderly and more prone to falls. Even mild trauma can result in catastrophic bleeding. Dabigatran’s action at the end of the clotting cascade – by direct inhibition of Factor II – renders typical approaches to reversal futile. In these cases, a high index of suspicion for progressive intracranial hemorrhage and low threshold for the initiation of dialysis might yield the best clinical outcomes. We propose the following treatment algorithm in patients presenting with intracranial bleeding in a setting of dabigatran use:

1. Cease all anticoagulant and antiplatelet medications;
2. Check all available coagulation parameters and reverse, or provide replacement where necessary;
3. Proceed to renal dialysis if risk of bleeding is high;
4. Where emergency intervention is indicated, give platelets and available recombinant factors prior to surgery.

Dabigatran is approved for use in many Asian countries including Australia, Japan, Malaysia, Singapore, and South Korea. Its indications in these countries include stroke prevention in AF and thromboprophylaxis after orthopedic surgery. In addition to concerns relating to low-energy intracranial trauma, major gastrointestinal bleeding complications have been reported. As a result, warnings have been issued which advise caution when using dabigatran in the elderly, in patients with renal impairment and concomitantly with other anticoagulants, including aspirin.

**Conclusion**

As neurosurgeons, it’s important to remain abreast of new developments in the area of anticoagulation. The compelling benefits of novel anticoagulants like dabigatran – for
Dwyer, et al.: Neurosurgical implications of dabigatran

Table 1: Citations for content in table provided below at end of title Comparison of Dabigatran etexilate and Other Commonly Used Anticoagulants[1-4,7,10]

<table>
<thead>
<tr>
<th></th>
<th>Dabigatran</th>
<th>Warfarin</th>
<th>Heparin</th>
<th>Enoxaparin</th>
</tr>
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<tbody>
<tr>
<td>Route</td>
<td>PO</td>
<td>PO</td>
<td>IV or SC</td>
<td>SC</td>
</tr>
<tr>
<td>Mechanism</td>
<td>Direct inhibition of thrombin</td>
<td>Reduced synthesis of clotting factors II, VII, IX and X</td>
<td>Potentiates anti-thrombin, thereby reducing thrombin and Xa activity</td>
<td>Potentiates anti-thrombin, thereby reducing thrombin and Xa activity</td>
</tr>
<tr>
<td>Bioavailability</td>
<td>6.5%</td>
<td>~100%</td>
<td>~30%</td>
<td>~100%</td>
</tr>
<tr>
<td>Onset of action</td>
<td>30 mins</td>
<td>36-72 hours</td>
<td>1-2 hours</td>
<td>3-5 hours</td>
</tr>
<tr>
<td>Half life</td>
<td>9-12 hours</td>
<td>20-60 hours</td>
<td>Unstable</td>
<td>Stable</td>
</tr>
<tr>
<td>Pharmacokinetics</td>
<td>Renal</td>
<td>Hepatic</td>
<td>Renal</td>
<td>Renal</td>
</tr>
<tr>
<td>Metabolisation</td>
<td>Yes, PPIs reduce absorption</td>
<td>Yes, multiple with clinical significance</td>
<td>Limited, caution with other anticoagulants</td>
<td>Limited, caution with other anticoagulants</td>
</tr>
<tr>
<td>Drug interactions</td>
<td>Nil</td>
<td>Yes, clinically significant</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Diet interactions</td>
<td>None</td>
<td>Regular INR</td>
<td>Regular APTT</td>
<td>Regular anti-Xa</td>
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<tr>
<td>Monitoring</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reversal agent</td>
<td>None</td>
<td>Vit K, FFP, Prothrombinex-VF</td>
<td>Protamine sulfate (limited efficacy)</td>
<td>Protamine sulfate (limited efficacy)</td>
</tr>
</tbody>
</table>

physicians, patients and health care administrators – insure that their routine use will see rapid adoption. An understanding of the medical benefits and surgical risks of these agents is essential in obtaining valid consent for neurosurgical procedures and understanding the limits they place on emergency neurosurgical intervention.

References


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