

## PRACTICE

### Safety Alerts:

## Reducing risks of tourniquets left on after finger and toe surgery: summary of a safety report from the National Patient Safety Agency

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### Recent Rapid Responses

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**Re: Reducing risks of tourniquets left on after finger and toe surgery: summary of a safety report from the National Patient Safety Agency 2011-12-07**

### Reducing the Risk of Digital Tourniquets: Product and Process

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I read the recommendations of the Rapid Response Report and the comments that have since been contributed. Together, the report and responses highlight the two significant risks associated with digital tourniquets: necrosis due to a retained tourniquet and injury due to excessive tourniquet pressure.

I applaud the work of Naim and Srinivasan regarding digital tourniquet pressures (1). In their comments regarding this article, Barai et al (2) suggest the use of glove tourniquets may be favored compared to CE marked tourniquets, based on the comparative pressure being more acceptable. Humphry et al (3) also acknowledge the risks of “unacceptably high pressures on the digital nerves” if an accurate size tourniquet is not used. These comments highlight the less dramatic, but more common complication of the use of digital tourniquets –neurovascular injury secondary to excessive pressure.

The recommended pressure for any upper extremity tourniquet is 200 mmHg (4), the “not to exceed” pressure is 300 mm Hg (5), and nerve injury occurs at 500 mm Hg (6). In Naim and Srinivasan’s study, the glove method applied an average pressure to the digit of 561 mm Hg, the elastic catheter 834 mmHg, and the commercial silicon band 636 mmHg. While Barai et al are correct that the glove applied the lowest pressures, all methods exceeded the pressure known to cause nerve injury. It would be considered negligent to use pressures of this magnitude when using a pneumatic tourniquet on an extremity, why are we comfortable with the use of such pressures on digits? These pressures are not only excessive, they are unnecessary- pressures of 150 mm Hg are noted to be “very adequate” to achieve hemostasis for a digit (7).

Pressure related injuries may occur quickly; reports note neurovascular injuries after 20 minutes of tourniquet application (8). Two studies performed using methods similar to current digital tourniquets reported tourniquet-induced nerve injury in 71% (9) and 77% (10) of patients. McEwen and Casey note that elastic bands, rolls and straps similar to current digital tourniquet methods apply substantially higher pressures than pneumatic tourniquets and warn that their use may increase the incidence of injury and unnecessarily expose the user to potential legal liability (11).

The inability of traditional methods to reliably apply a safe pressure and their potential to be forgotten on a digit led to the development of the T-Ring, a one size fits all tourniquet that adjusts to any digit size, eliminating the risk of excessive pressure. A recent study by Lahham showed the T-Ring applied a very consistent pressure (149 – 165 mm Hg) on all digit sizes (12). Unlike other methods, the T-Ring did not have to be correctly sized, and in every case it applied the lowest pressure of all methods (surgical glove, Penrose drain, Tourni-cot), while consistently preventing digital blood flow. The T-Ring is also the most conspicuous method; extending 14 mm from the digit, compared to 2 mm for the glove and 3-4 mm for the commercial bands (Tourni-cot, Toe-niquet).

The response by Humphry et al, The danger with finger tourniquets: Product or Process? (3), notes that “there are CE marked digital tourniquets that are clearly not fit for intended purpose”, because they are inconspicuous, have been left on digits and may apply excessive pressure if incorrectly sized. Unfortunately, these risks are associated with all traditionally used digital tourniquets. There are numerous reports of commercial bands and gloves being left on digits, and Naim’s study demonstrates that commercial bands, gloves and elastic catheters apply excessive pressure even when correctly sized. Humphry et al do note that glove tourniquets may apply pressures that are acceptable (13); however, the same study found pressures of 630 mm Hg if a glove one half size too small was used.

Additionally, while applying an artery clip will reduce the risk of leaving a tourniquet on a digit, this technique significantly increases the pressure applied to the digit (12). The recent case report (14) by Selvan et al demonstrates that applying a high profile instrument like an artery clip to a low profile tourniquet does not insure that the tourniquet will be removed. A better solution is to use a tourniquet that is conspicuous in its own right.

In attempting to manage digital tourniquet risks, the following must be acknowledged:

- 1) there is an inability to monitor the tourniquet pressure
- 2) traditional methods generate pressures that are highly variable, excessive and dependent on the application method
- 3) the least amount of pressure necessary to achieve hemostasis must be used
- 4) a conspicuous tourniquet must be used

While there are numerous references in the literature that note the above, these points are inherently obvious. If we want to minimize digital tourniquet complications, we cannot continue to justify the use of makeshift methods and commercial devices that have been left on digits and shown to apply excessive pressure.

Finally, there are two reasons that following a safe tourniquet process alone will not sufficiently reduce tourniquet complications. First, while the process will help minimize the risk of prolonged application time and a forgotten tourniquet, it will do little to reduce the risk of neurovascular injury resulting from excessive pressures. Secondly, there will always be a greater risk of complications outside the operating theater, where the process is less familiar, the staffing stretched, the environment is chaotic, and patients with conditions that make them susceptible to injury from excessive tourniquet pressures have not always been identified. While a process will certainly help, there will be a higher rate of process neglect in these less controlled settings. If we want to minimize the risk of digit necrosis from a retained tourniquet or injury related to excessive pressure, a process of tourniquet use needs to be followed. More importantly, however, providers must use a highly conspicuous tourniquet that applies a safe and effective pressure with each application, regardless of the user, the size of the digit or method of application.

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**Fingertip amputation**



**Open joint from skill saw injury**

**Competing interests:** Dr. William Green is the Inventor of "The T-Ring", a CE marked, sterile tourniquet for digits manufactured in USA

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