matters

Effectiveness of an "axillary ring block" in reducing tourniquet pain in volunteers: Double-blind, randomized crossover clinical trial

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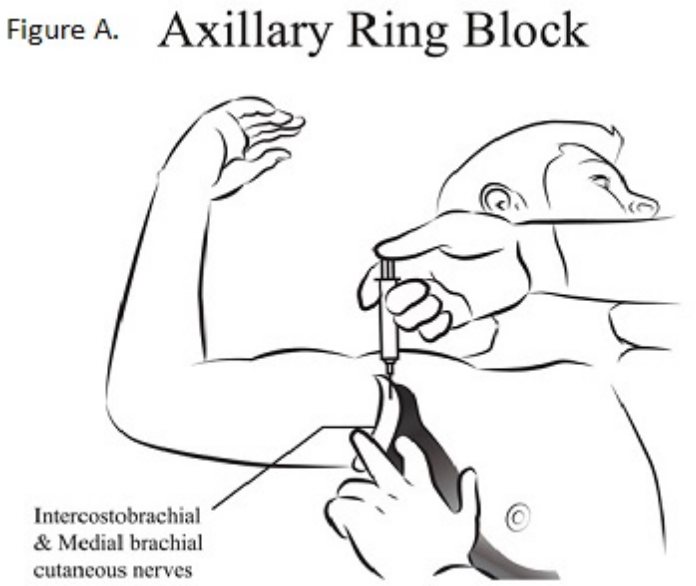
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Abstract
Background and Objectives: Orthopedic surgeons commonly use an upper arm tourniquet to avoid excessive surgical bleeding. An "axillary ring block" has been used to help patients better tolerate the discomfort from the tourniquet. The primary objective of this study was to determine if an "axillary ring block" with 0.25% bupivacaine with epinephrine 1:200,000 was effective in decreasing tourniquet pain.
Methods: This was a prospective, controlled, blinded, crossover trial involving 24 adult volunteers. Twelve men and twelve women underwent subcutaneous axillary ring injection with 0.25% bupivacaine with epinephrine 1:200,000 or normal saline prior to inflation of an upper arm tourniquet. Approximately 1 month later, all subjects returned to have the opposite solution injected. The primary endpoint was the total time that the tourniquet was inflated.
Results: The volunteers who were injected with bupivacaine/epinephrine tolerated the upper arm tourniquet for a longer period than those who received saline (mean of 30.5 minutes) vs. 22.4 minutes (p= 0.014). The bupivacaine/epinephrine axillary ring injection also decreased pain at the tourniquet site by 1.0 pain scale unit (p=0.025) and pain below tourniquet by 1.1 units (p=0.001).
Conclusions: We demonstrated that bupivacaine axillary ring injection may decrease the level of discomfort under an upper arm tourniquet.

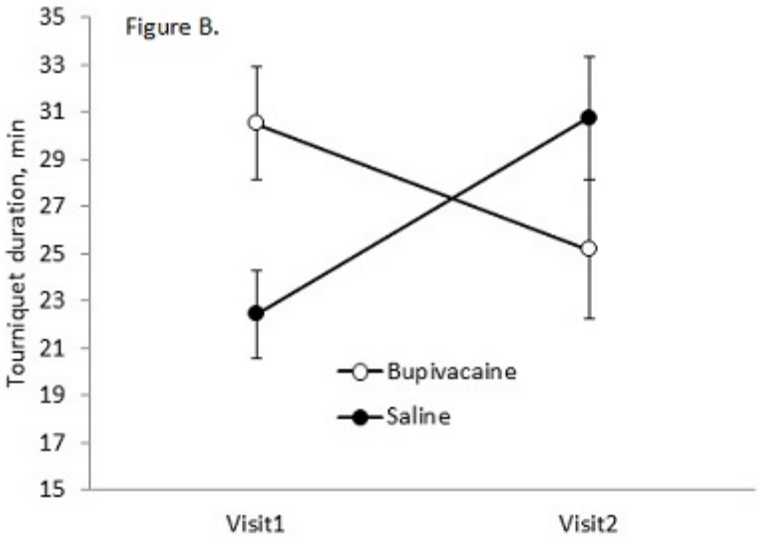
Objective
This study was designed to determine the effectiveness of the axillary ring block in decreasing tourniquet pain in healthy volunteers.

Introduction
Discomfort secondary to the use of a pneumatic tourniquet for limb surgery is a common obstacle in anesthetic management. Prior studies have shown that awake volunteers experience a vague, dull pain after tourniquet inflation that is tolerated for an average duration of 31 minutes, extended to 45 minutes with sedation [2] [3]. Prolonged tourniquet inflation (>30-60 minutes) produces a gradual increase in heart rate and blood pressure, the incidence of which is related to the type of anesthesia [2]. A cutaneous mechanism is thought to be responsible, as demonstrated by the attenuation of tourniquet discomfort by topical eutectic mixture of local anesthetic agents (EMLA) [4] [5]. A sympathetically mediated pathway has essentially been disproven by the lack of effectiveness of stellate ganglion block for upper arm tourniquet discomfort, although the study was small [6]. The leading hypothesis for the mechanism of tourniquet pain is the loss of inhibition of unmyelinated, slow-conducting C fibers. These fibers are usually inhibited by fast, myelinated A-delta fibers which are blocked after approximately 30 minutes of tourniquet inflation and mechanical compression [2].
After brachial plexus anesthesia, the anatomy and innervation of the upper arm has led to an additional subcutaneous infiltration of local anesthetic of the medial aspect of the upper arm [7]. This is called the "axillary ring block," and it targets the intercostobrachial nerve and the medial cutaneous nerve of the arm. The intercostobrachial nerve is the lateral cutaneous branch of the ventral primary ramus of T2. It provides innervation to the skin of the axilla and the medial aspect of the proximal arm. The

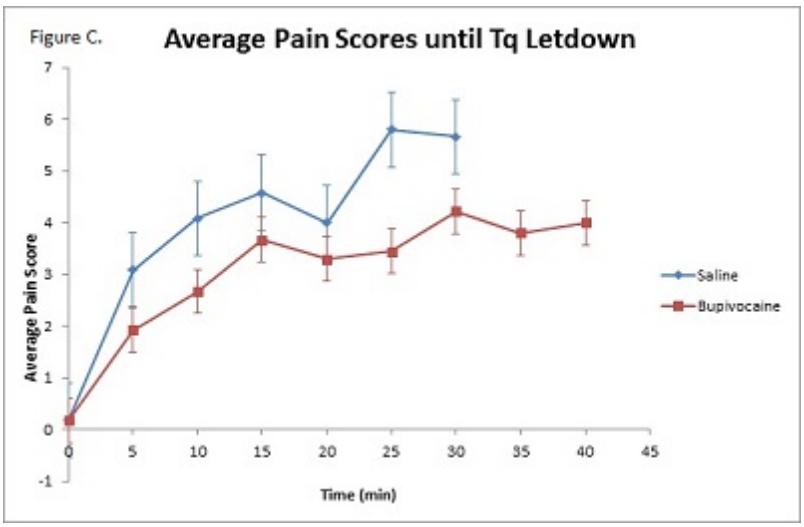
intercostobrachial nerve communicates with the medial cutaneous nerve of the arm, which is a branch of the medial cord of the brachial plexus. Both of these nerves are routinely missed with supraclavicular or infraclavicular brachial plexus anesthesia, and this study was designed to determine the effectiveness of the axillary ring block in decreasing tourniquet pain. It was hypothesized that the axillary ring block will decrease tourniquet pain and increase tourniquet tolerance period.



a



b



c

Figure D. Characteristics of Study Participants

		Sequence allocation group		
		Bupivacaine-Saline	Saline-Bupivacaine	Total
n		12	12	24
Age	Mean(SD)	32(10)	32(11)	32(10)
Sex	Female	6	6	12
	Male	6	6	12
Dominance	Dominant	6	6	12
	Non-dominant	6	6	12
Laterality	Left	6	7	13
	Right	6	5	11
Race	Caucasian	11	8	19
	Asian	1	2	3
	Black	0	1	1
	Hispanic	0	1	1

d

Figure E. Experiment results by treatment group during the first study visit

	Treatment	Mean	Lower 95% CL	Upper 95% CL	p-value
Time Tourniquet On	Bupivacaine	30.5	26.1	35.0	
	Saline	22.4	18.0	26.9	
	difference	-8.1	-14.0	-2.1	0.014
Pre-deflation pain at tourniquet, 0-10 NRS	Bupivacaine	3.6	2.6	4.6	
	Saline	4.6	3.6	5.6	
	difference	1.0	0.1	1.8	0.025
Pre-deflation pain below tourniquet, 0-10 NRS	Bupivacaine	5.0	4.0	5.9	
	Saline	6.1	5.2	7.1	
	difference	1.1	0.4	1.8	0.001

e

Figure Legend

Figure A. Illustrated representation of the axillary ring block [1] . Figure B. Significant carryover effect was observed (first arm received bupivacaine during the first visit and saline during the second visit; second arm received saline at the first visit and bupivacaine at the second visit) Figure C. Average pain scores at the tourniquet site and time of inflation for volunteers who received a bupivacaine axillary ring injection during their first session.Figure D. Characteristics of study participants.Figure E. Experimental results by treatment during the first study visit.

Results & Discussion

Twenty-four healthy ASA physical status I or II men and women were recruited (Figure 1). All study participants received the assigned intervention in compliance with the study protocol. Significant carryover effect was observed on the duration of tourniquet placement across the two visits (p = 0.049, Figure 2). Therefore, the data only from the first visit was analyzed and presented.

The volunteers who were injected with bupivacaine tolerated the upper arm tourniquet for longer period than those who received saline (mean of 30.5 minutes (95% confidence interval 25.3 to 35.4 minutes) vs. 22.4 minutes (95% CI 18.3 to 26.5), p-value 0.014, Table 2). Bupivacaine axillary ring injection also decreased pain at the tourniquet site by 1.0 pain scale unit (95% CI 0.1 to 1.8, p=0.025) and pain below tourniquet by 1.1 units (95% CI 0.4 to 1.8, p=0.001) (Figure 2, Table 2).

Sensory and motor changes of the hand were found to be quite consistent between study participants. The various times required for the tourniquet to produce decreased sensation and grip strength were similar despite bupivacaine or saline injections. All volunteers demonstrated complete resolution of tourniquet-related sensory and motor changes within 15 minutes of tourniquet deflation. Patients who received bupivacaine were more likely to have sensory changes (touch and pinprick) immediately before the tourniquet deflation (Fisher exact test p=0.042 and 0.041, respectively), but not changes in muscle strength (Table 3). There were no cases of prolonged sensory changes over the medial upper arm after the axillary ring injections.

In this prospective crossover study, we have demonstrated that bupivacaine axillary ring injection decreases reported pain scores in awake subjects after upper extremity tourniquet inflation. However, the separation of the axillary ring block from overall brachial plexus anesthesia may have limited clinical applicability. All patients at our institution who undergo upper extremity surgery with a tourniquet in the absence of

general anesthesia have brachial plexus anesthesia. In this study, volunteers received only an axillary ring injection, leaving the majority of the upper arm with intact sensation. It is difficult to determine the exact contribution of the medial upper arm to the overall pain scores from the tourniquet site. The decreased pain score of one point on a ten-point scale may or may not be clinically significant.
The tourniquet's effect on the lower arm also presented a source of distracting discomfort, potentially altering both pain scores and the overall tourniquet time tolerated. Patients with a brachial plexus block would likely not experience this distal discomfort. It is also very likely that this study demonstrates carryover bias. The volunteers' first experience with the axillary ring injection and tourniquet inflation may have affected their second experience. For example, the volunteers who were injected with bupivacaine during their first experience may have reported a certain amount of discomfort and allowed the tourniquet to remain inflated for a certain period of time. During their second visit, injected with saline, their reported pain scores and length of tourniquet time may have been affected by their prior experience. Perhaps that explains why a significant decrease in pain at the tourniquet site was only seen in volunteers who were injected with bupivacaine during their first study session. However, the difference seen between the groups during their first visit would not be subject to the carryover effect, making those results perfectly valid.

Additional Information

Methods and Supplementary Material

Please see https://sciencematters.io/articles/201605000003.
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Ethics Statement

This study was done in compliance with the UNC IRB.

Citations

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