

THE SAFETY AND EFFICACY OF IMPROVISED TOURNIQUETS IN LIFE-THREATENING HEMORRHAGE

A systematic review

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Introduction

After the USA military had seen a drastic decrease in mortality after implementing widespread use of tourniquets (TQ), a worldwide program to train civilian 'bystanders' as immediate responders¹ in how the use a TQ. As public access to TQ's has not yet been achieved, bystanders may want to improvise a TQ with materials found at the scene. In this systematic review the evidence on design, efficacy and safety of improvised TQ's is investigated.



Application of band-and-windlass improvised tourniquets

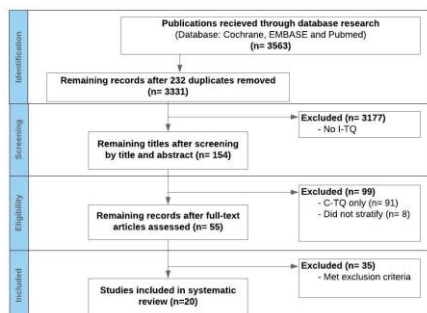
Ineffective TQ's may provide for paradoxical bleeding². Also, improvised designs are more at risk to cause pain³.

Author, Year of Publication	Design, success rate	Reported complication rate	
King, R.B. 2006	Cloth with wooden dowel	Pulse palpation success Ideal 14/20 (70%) TQ over winter clothing 16/20 (80%)	Unknown
		Echo Doppler success Ideal 6/20 (30%) TQ over winter clothing 10/20 (50%)	
	Surgical tubing	Pulse palpation success Ideal 20/20 (100%) TQ over winter clothing 18/20 (90%)	
		Echo Doppler success Ideal 20/20 (100%) TQ over winter clothing 18/20 (90%)	
Swan, K.G. 2008	Rubber tubing	Upper Arm 10/10 (100%) Upper Leg 10/10 (100%) Lower Arm 10/10 (100%) Lower Leg 10/10 (100%)	1/80 (0.01%)
		Cloth with wooden stick	
	Surgical tubing wrapped around extremity tightly	Upper extremity 12/20 (60%) Lower extremity 15/20 (75%)	
		Canvas belt	
Guo, J.Y. 2011	Upper extremity 12/20 (60%) Lower extremity 15/20 (75%)	Unknown	
Heldenberg, E. 2015	Improvised Russian tourniquet, triangular bandage, wooden dowel.	Lower extremity = 62%	Unknown
Altamirano, M.P. 2015	T-Shirt with 6 chopsticks taped together turned 180 degrees	No windlass	Unknown
		54/80 (68%)	1/80 (1%)
Kragh, J.F. Jr. 2015	Chop stick	1 Stick 17/40 (42%) 2 Sticks 40/40 (100%)	111/249 (45%)
		Pencil 21/40 (52%) 37/40 (92%)	
		Craft stick 0/40 (0%) 24/40 (60%)	
		3 Sticks 33/40 (82%) 4 Sticks 20/20 (100%)	
Lyles, W.J. III 2015	Triangular bandage	8/20 (40%)	0/60 (0%)
	Bandana	2/20 (10%)	

Author name, pub year	Design, success rate	Reported Complication rate	
Kragh, J.F. 2008	Cloth and wooden dowel 3/7 (42%) of limbs	String, iv tube 2/8 (25%) of limbs	12/16 (80%)
Inaba, K. 2015	No design mentioned 7/7 (100%)		0/7 (0%)
Lakstein, D. 2002	Wide rubber band wrapped around limb 13/18 (72%)	Improvised tourniquet, (2 belts, 1 wire) 2/3 (66%)	7/110 (6%)
Larsen, J. 2004	String, belts and cloths 0/18 (0%)		3/18 (17%)
Zietlow, J.M. 2011	Belt 0/3 (0%)		0/3 (0%)
King D.R. 2012	Cloth and wooden dowel. 0/2 (0%)		Not mentioned
King, D.R. 2015	27 improvised tourniquets. Most encountered was surgical tubing wrapped tightly and then twisted with a clamp. Although no numbers mentioned, most were ineffective (venous) tourniquets		Not mentioned
Kue, R.C. 2015	Surgical tubing wrapped around limb, twisted with a clamp. 87/95 (91%)	Belts 0/3 (0%)	0/98 (0%)
Passos, E. 2014	Neck tie, belt, handkerchief. No effectiveness described		0/4 (0%)
Schroll, R. 2015	40/197 improvised. Design not described. Hemorrhage control percentage not described.		Damage all similar to commercial devices
Malo, C. 2015	Belt and Seatbelt combined 1/1 (100%)		1/1 (100%)
Dayan, L. 2017	Cloth with wooden dowel. In place for 11 hours 1/1 (100%)		1/1 (100%)
Kragh, J.F. 2007	Wide strap with spring clip. 0/1 (0%)	Cloth with wooden dowel 1/1 (100%)	0/1 (0%)

Methods

A systematic review was performed according to the PRISMA statement in the databases PubMed, EMBASE.com and the Cochrane Library.



Studies were assessed for risk of bias using the ROBINS-1 tool. Due to expected substantial heterogeneity in study design and study population no data pooling was performed.

Results

Twenty studies were included. Mainly, studies on manikins, pre-clinical trials, and retrospective analyses were found. Commercial TQ outperformed all types of improvised TQ significantly. The band-and-windlass design achieved most consistent success rates (close the success rates of commercial TQ's) across all studies designs.

Conclusion

Little evidence on improvised TQ's is available regarding 1) optimal design, 2) complication rate and 3) reliability. The use of improvised TQ's is not supported due to low efficacy and safety concerns. Theoretically, a proper design and application of an improvised TQ may save lives but implicates the availability of the proper materials and prior training (as in commercial TQ's)

References

- Jacobs JACS 2013,
- King J Trauma 2015,
- Wall JOSM 2015

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