REVIEW ARTICLE

Nonpneumatic Antishock Garment: A Promising Tool for Management of Obstetric Hemorrhage with Hypovolemic Shock

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Abstract

Aim: To review the role of nonpneumatic antishock garment (NASG) as a temporary measure to stabilize patient in postpartum hemorrhage (PPH) while waiting for a more definitive treatment.

Background: Though several studies have suggested the efficacy of NASG as a temporary measure to resuscitate women with obstetric hemorrhage, its precise role remains to be delineated. In this review, we extensively review available evidence and current recommendations regarding the use of NASG in PPH.

Review results: Current review included several observational studies and one cluster randomized controlled trial (RCT). The results of this review suggest that the application of NASG significantly reduces the amount of obstetrical blood loss. However, with regard to reduction in maternal mortality and severe morbidity, the results are inconclusive with some studies showing significant reduction while others not.

Conclusion: Nonpneumatic antishock garment appears to a promising tool in reducing the maternal mortality and severe morbidity in PPH. In future, well-conducted randomized controlled trials employing appropriate sample size will further help in clarifying the role of NASG as a temporary measure to resuscitate women with PPH.

Clinical significance: Nonpneumatic antishock garment appears to be a promising device for resuscitation of women with PPH.

Keywords: Maternal mortality, Nonpneumatic antishock garment, Postpartum hemorrhage.

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History of Antishock Garments

The antishock garments were probably first used in 1900 when George Crile developed an inflatable pressure suit to maintain blood pressure during surgery. It was subsequently modified and used in Vietnam war to resuscitate and stabilize soldiers suffering from traumatic injuries during transportation. In the 1970s, it underwent further modification into a half suit called military antishock trousers (MAST) or pneumatic antishock garment (PASG) and was used to control shock due to lower body hemorrahge.[1,2] In the 1990s, its use was recommended by the American College of Obstetrics and Gynecology, which was subsequently revoked.[3] Later, NASG was developed and first used in Pakistan as a temporary measure to improve blood flow to vital organs in PPH while waiting for more definitive treatment.[4]

NASG: How Does it Work?

Nonpneumatic antishock garment is a washable, low-weight, reusable (up to 40 times) compression suit made of neoprene (a synthetic rubber). It consists of nine segments (three for each leg, one for pelvis, and one double segment for abdomen) which close tightly around legs, abdomen, and pelvis with Velcro. On application, NASG exerts a circumferential pressure (usually up to 20–40 mm Hg) on blood vessels in legs, pelvis, and abdomen thereby decreasing blood flow in these vessels with a resultant improvement in blood circulation to more vital organs such as the brain, lungs, and heart.[5–7] It also serves to reduce blood loss from the uterus by decreasing the uterine blood flow through compression of internal iliac artery. It allows access to perineal region and thus vaginal procedures can be performed easily without removing the suit. The abdominal segment can also be selectively opened allowing easy surgical access. It is relatively cheap and easy to apply. Mere one hour of training is enough to educate nurses and primary care provides about its use. It does not exert pressure greater than 70 mm Hg and thus there is no risk of ischemia of extremities or compartment syndrome.[5–7]

PPH—Magnitude of the Problem

Globally PPH is the commonest cause of maternal deaths accounting for 25% of maternal mortality. The estimated prevalence of PPH varies from 2 to 11% of pregnancies. When defined by a blood loss of ≥500 mL, its prevalence varies from 10.5 to 26% in Africa, from 2.6 to 8% in Asia, from 6.3 to 13% in North America and Europe, and from 8 to 8.9% in Latin America.[8–10] When defined as a blood loss of ≥1,000 mL, the estimated global prevalence ranges from 1.9 to 10.5%.[8–10] Worldwide in 2008, it accounted for 1,27,000 maternal deaths with half of these deaths occurring in Asia and Africa.[11]

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Postpartum hemorrhage continues to be a major cause of maternal mortality also in India. The reported incidence of PPH ranges from 2 to 4% after vaginal and 6% after cesarean delivery. Overall, it accounts for approximately 19.9% of maternal mortality in India which amounts to 78,000–1,17,000 deaths annually.[11,12]

Role of NASG in PPH: Review of Literature

Hensleigh[4] first reported the use of NASG in six women with PPH. Two women were pulseless while three were confused. He reported dramatic recovery in mean arterial pressure and general condition of these women with cessation of bleeding as long as NASG was in place. He stressed on the need for randomized controlled trials to establish its efficacy in PPH.

Subsequently, Miller et al.[7] evaluated the role of NASG in addition to standard care in the management of PPH at four tertiary care centers in Egypt. They enrolled 364 women with PPH and shock (defined as either a pulse rate >100 beats/minute or systolic blood pressure <100 mm Hg). Nonpneumatic antishock garment was used in 206 women while 158 women served as control group. Nonpneumatic antishock garment was left in place for vaginal procedures. For abdominal procedures, abdominal segment was opened while remaining segments were left in place. Nonpneumatic antishock garment use resulted in a statistically significant 50% decrease in the amount of vaginal blood loss as measured by drape. There was a corresponding decrease in maternal morbidity and mortality, but the difference was not significant.

In the same year, Miler et al.[13] published data on the use of NASG in women with severe obstetric hemorrhage from 10 tertiary care centers in Egypt and Nigeria. Postpartum hemorrhage was defined as severe based on the estimated blood loss of >1,000 mL at admission and pulse rate of 120/minute. The study included 263 women out of whom 159 received NASG, while 104 served as control group. Nonpneumatic antishock garment use resulted in statistically significant 64% reduction in median blood loss (from 740 mL in control group to 250 mL in NASG group). There were fewer deaths [n = 3/263 (1.1%)] and severe morbidity [(n = 2/263 (0.8%)] in NASG group compared to control group (seven deaths and five severe morbidities) though the difference was statistically insignificant. But, when both death and severe morbidity were combined, NASG group did significantly better than control group [relative risk (RR): 0.28%; 95% CI: 0.1–0.77]. Miller et al.[14] reiterated their data from Egypt in 2007 and suggested NASG to be a useful device in the prevention of maternal mortality from obstetrics hemorrhage in developing countries. Geller et al.[15] proposed a continuum of care model for PPH and recommended the use of NASG in PPH. Subsequently, several smaller studies[16,17] confirmed the previous findings of significant reduction in blood loss following NASG use in PPH.

Mourad-Youssif et al.[18] published data on the use of NASG in 854 women with PPH (defined as blood loss of >750 mL) and at least one clinical sign of shock (systolic blood pressure <100 mm Hg or pulse rate >100 beats/minute). Nonpneumatic antishock garment was used in 511 women while 353 women served as control group. All the women received standard care for the management of PPH. Women with NASG did better than control group. The benefits included are as follows: a 50% decrease in the measured blood loss postintervention (p <0.0001), a significant decrease in emergency hysterectomy (RR: 0.44; 95% CI: 0.23–0.86), decrease in severe morbidity and mortality combined (RR: 0.32; 95% CI: 0.19–0.53), decrease in morbidity (RR: 0.24; 95% CI: 0.09–0.67), and mortality (RR: 0.35; 95% CI: 0.19–0.62). Severe morbidity was defined as heart failure, renal failure, acute respiratory distress syndrome (ARDS), or cerebral impairment (seizures, unconsciousness, or focal deficits) lasting for >24 hours after recovery from shock.

In another study[19] involving 1,442 women (835 in NASG group) with PPH (>750 mL of blood loss) and at least one sign of shock, the application of NASG was associated with the following benefits: statistically significant reduction in the amount of blood loss from mean of 444 mL in control group to 240 mL in study group, decrease in maternal mortality by 2.8% from 6.3% (control group) to 3.5% (study group) (RR: 0.56; 95% CI: 0.35–0.89), decrease in severe morbidity by 3% from 3.7% (control group) to 0.7% (study group) (RR: 0.2; 95% CI: 0.08–0.5), decrease in emergency hysterectomy by 4.9% from 8.9% (control group) to 4% (study group) (RR: 0.44; 95% CI: 0.23–0.86). The number of women needed to be treated to prevent one mortality/morbidity was 18. All these benefits were seen despite the fact that a significantly higher number of women in NASG group had mean arterial pressure <60 mm Hg compared to control group.

Sutherland et al.[19] estimated economic benefits of NASG in women. For every 1,000 women, the use of NASG was estimated to improve disability adjusted life years (DALYs) by 357 days in Egypt and 2,063 days in Nigeria. The use of NASG was associated with savings of 9,489 US dollars per 1,000 women in Egypt and 6,460 US dollars per 1,000 women in Nigeria.

Miller et al.[7] subsequently conducted a cluster RCT in Zambia and Zimbabwe. They enrolled 880 women (NASG group—405; control group—475). Though there was 46% composite decrease in mortality and 54% composite decrease in an extreme adverse outcome in NASG group, the difference was statistically insignificant (p = 0.37 and 0.22, respectively). However there was a significant decrease (p = 0.03) in time to recovery from shock.

El Ayadi et al.[20] conducted a systemic review of all the studies published till 2013. They reported a significant reduction (odds ratio: 0.62; 95% CI: 0.44–0.86) in mortality among all women with PPH and in women with severe shock (odds ratio: 0.41; 95% CI: 0.20–0.84). Nonpneumatic antishock garment use resulted in 50% reduction in the amount of median blood loss. Pillegi-Castro et al.[21] in a systemic review stressed on the importance of using NASG in resource limited settings where delays in transport are common.

In a study[21] conducted at Rural Tanzania (n = 410 women with PPH and shock), the application of NASG (n = 297) by trained workers in real world setting before transportation resulted in reduction in case fatality rate by 67% (RR: 0.33; 95% CI: 0.19–0.6). Magwali et al.[22] reported a significant reduction (p < 0.001) in measured blood loss but not maternal mortality in women managed with NASG compared to women who did not receive NASG.

Indian Studies

There are only a few Indian studies evaluating the role of NASG in women suffering from PPH and shock. Maknikar et al.[23] reported 1,541 women with severe PPH (blood loss >1 L). Postpartum hemorrhage occurred in approximately 1.3% of all deliveries. Of these, 260 women had shock as suggested by a systolic blood pressure <90 mm Hg or pulse rate >100 beats/minute. One hundred thirty-nine women received NASG while 121 women served as control group. Both the groups received appropriate care according to standard guidelines. Shock was graded as severe if there was an associated impairment of consciousness (n = 122;

NASG group: 53 women; control group: 69 women). There was a trend ($p = 0.07$) toward decreased mortality with the use of NASG among all women ($n = 260$), while there was a significant reduction in mortality ($p = 0.01$) when only women with severe shock ($n = 122$) were analyzed.

In another study Sharma et al.[6] evaluated feasibility and success of NASG implementation at public health centers in the Indian state, Bihar. They extensively trained health care workers in the use of NASG followed by assessment of their practical use. To their dismay, it was found that despite intensive training, this initiative did not make any difference to the management or outcome of the patients with PPH. The main reason for the lack of efficacy included lack of skills among healthcare providers regarding the use and reuse of NASG as well as identification of PPH, despite training.

Table 1 summarizes major studies on the use of NASG in PPH. The evidence regarding the utility of NASG in PPH provided by these studies ranges from low to average as most of these studies were observational except one cluster RCT.[7] The subjects who received NASG in these studies were compared with patients in preintervention period (before NASG became available), which is not the ideal way of comparison. The results in favor of NASG could be due to evolution of better postpartum care with time rather than the use of NASG. In addition, two studies[22,23] were not peer-reviewed but just conference papers.

NASG: Current Status

International Federation of Gynecology and Obstetrics (FIGO) recommend the use of NASG in (1) PPH with estimated blood loss >500 mL or systolic blood pressure <100 mm Hg or pulse rate >100 beats/minute at primary care level or during transport and (2) PPH with estimated blood loss >1,000 mL or systolic blood pressure <90 mm Hg or pulse rate >110 beats/minute at higher facilities. It is granted grade B recommendation as a temporary measure. Nonpneumatic antishock garment should be applied rapidly starting at ankles and should be in place till bleeding decreases to <25–50 mL/hour or till a source of bleeding can be identified.[24]

The Federation of Gynecology and Obstetrical Societies of India (FOGSI) also recommends countries to determine the degree of contribution of hemorrhage to maternal mortality. If hemorrhage makes a significant contribution to maternal mortality and delays during transport or in receipt of blood products contribute significantly to mortality, NASG use should be considered and training (both through dictation and hands on) should begin at referral institutes followed by training to workers at primary health care and transport facilities. They also recommend that NASG be added to the curricula of all health care providers who attend to pregnant women including resident doctors, nurses, midwives, and anesthesiologist and that NASG should be provided at all levels of healthcare including nursing homes and ambulances.

Table 1: Summary of main studies evaluating the role of NASG in PPH

			Number of women			
Study details	*Type of study*	*Inclusion criteria*	*Women who received NASG*	*Women who did not receive NASG*	*Result*	*Quality of evidence*
Miller et al.[5] 2006 Egypt	Observational	750 mL blood loss + either SBP <100 mm Hg or PR >100/minute	206	158	Significantly lower (p <0.001) median vaginal blood loss in NASG group (250 mL) compared to control group (700 mL)	Low
Miller et al.[13] 2006 Egypt Nigeria	Observational	Estimated blood loss >1,000 mL; PR >120/minute	159	104	Significantly lower (p <0.05) median vaginal blood loss in NASG group (250 mL) compared to control group (700 mL)	Low
					Significantly lower (p <0.05) combined morbidity and mortality in NASG group	
Miller et al.[16] 2009 Nigeria	Observational	750 mL blood loss + either SBP <100 mm Hg or PR >100/minute	86	83	Significantly lower (p <0.001) mean vaginal blood loss in NASG group (73.5 ± 93.9 mL) compared to control group (340.4 ± 248.2 mL)	Low
					Lower maternal mortality in NASG group (RR: 0.32; 95% CI: 0.14–0.72)	
Miller et al.[17] 2010 Egypt	Observational	1,000 mL blood loss + either SBP <100 mm Hg or PR >100/minute			Significantly lower (p <0.01) mean vaginal blood loss in NASG group (253 mL) compared to control group (379 mL)	
					Lower extreme adverse outcome (either mortality or cardiac, respiratory, renal, or cerebral impairment) maternal mortality in NASG group (RR: 0.38; 95% CI: 0.17–0.85)	

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Study details	Type of study	Inclusion criteria	Number of women: Women who received NASG	Number of women: Women who did not receive NASG	Result	Quality of evidence
Miller et al.[7] 2010 Egypt Nigeria	Observational	750 mL blood loss + either SBP <100 mm Hg or PR >100/minute	835	607	Significantly lower ($p < 0.001$) mean vaginal blood loss in NASG group (240 mL) compared to control group (444 mL) Lower mortality (RR 0.56, 95% CI: 0.35–0.89), severe morbidity (either mortality or cardiac, respiratory, renal, or cerebral impairment) (RR 0.20, 95% CI: 0.08–0.50) and emergency hysterectomy (RR 0.44, 95% CI: 0.23–0.86) in NASG group	Low
Ojengbede et al.[24] 2011 Nigeria	Observational	750 mL blood loss + either SBP <100 mm Hg or PR >100/minute	174	114	Significantly lower ($p < 0.0001$) mean vaginal blood loss in NASG group (50 mL) compared to control group (350 mL) Lower maternal mortality (RR 0.31, 95% CI 0.15–0.64; $p = 0.0007$ in NASG group)	Low
Miller et al.[7] 2013 Zambia Zimbabwe	Cluster RCT	Obstetric hemorrhage + at least two of the following 500 mL blood loss SBP <100 mm Hg PR >100/minute	405	482	Significantly lower ($p < 0.03$) time to reversal of shock in intervention group	Average
Magwali et al.[22] 2012 Zimbabwe	Observational	Estimated blood loss >500 mL plus signs of vital organ dysfunction	197	231	Significantly lower ($p < 0.01$) mean vaginal blood loss in NASG group (191.16 ± 293.71 mL) compared to control group (482.96 ± 616.21 mL)	Low
Maknikar et al.[23] 2012 India	Observational	>1,000 mL estimated blood loss + hypovolemic shock (SBP <90 mm Hg or PR >100/minute)	121	139	Trend toward lower ($p < 0.07$) maternal mortality in NASG group	Low

NASG, nonpneumatic antishock garment; PPH, postpartum hemorrhage; SBP, systolic blood pressure; PR, pulse rate; RR, relative risk; CI, confidence interval; RCT, randomized controlled trial

International Federation of Gynecology and Obstetrics also advises NASG should be considered as part of continuum of care for PPH and not a stand-alone intervention.[24]

NASG: Future Directions and Conclusions

The current recommendations (FIGO) on the use of NASG are based on five observational studies and one cluster RCT. Though observational studies showed benefits both in terms of maternal mortality and morbidity with NASG, RCT failed to document the same. Though NASG seems to be an attractive option, in future, well-conducted double-blinded RCTs with appropriate sample size are needed to further delineate its role in women with PPH.

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