ORIGINAL CONTRIBUTION

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The relationship between pressure and volume when using Rapid Rhino® packs in the management of epistaxis*

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SUMMARY

Despite the popularity of Rapid Rhino packs, there are no clear guidelines regarding the volume of air to be inflated when used in the management of epistaxis. The manufacturers suggest that subjective assessment by pilot cuff palpation is used to guide inflation. However, studies have clearly demonstrated that clinicians are poor at judging balloon pressure by pilot cuff palpation when used in other settings.

Our objective was to investigate the relationship between the volume of air inflated and the resultant intra-nasal pressure generated by nasal balloon packing. Twelve healthy subjects were packed with 5.5 cm Rapid Rhino packs, which were connected to a manometer and 20 ml syringe via a 3-way tap in a closed circuit. Increments of 2.5 mls of air were inflated and the resultant intra-nasal pack pressure was measured. There appeared to be a linear relationship between increasing volume and pack pressure. However, between individuals, there was a large variation in the intra-nasal pack pressure produced for a given fixed volume of air inflated. This is presumably due to variations in nasal anatomy. It may be that a manometer-measured, pressure guided nasal pack inflation technique would represent best practice, especially for less experienced staff.

Key Words: Rapid Rhino, nasal pack, volume, pressure, epistaxis

INTRODUCTION

Nasal pack insertion is an accepted treatment for the management of uncontrolled epistaxis. A range of different types of nasal tampon/packs is available. Several of these contain an inflatable balloon, which has the advantage of providing raised intra-nasal pack pressure whilst being deflatable for ease of pack insertion and removal. In our department the most commonly available nasal packs are the Merocel® and the Rapid Rhino®. Previous trials have demonstrated that the Rapid Rhino® is superior in reducing discomfort levels on pack removal as well as having a lower re-bleed rate on pack removal [1-3].

Despite the popularity of Rapid Rhino® packs, there are no clear guidelines regarding the volume of air to be inflated when used in the management of epistaxis. It is suggested by the manufacturers that subjective assessment by pilot cuff palpation is used to help guide inflation [4]. However, studies have clearly demonstrated the poor inter-rater reliability of pilot cuff pressure palpation when used in other settings [5,6].

Junior doctors in A and E, new to the specialty or cross covering ENT, are often required to insert and inflate these packs but are given little guidance or training on how much air to inflate.

Our objective was to investigate the relationship between the volume of air inflated and the resultant intra-nasal pressure generated by nasal balloon packing. The aim of this study was to provide new information, which might help guide best practice when using inflatable balloon nasal packing devices in the future.

METHODS

Twelve normally fit and healthy subjects between the ages of 26-34 were included in the study (9 male and 3 female). They were excluded if they had a history of significant sinonasal disease, septal deviation or previous nasal surgery. All 12 subjects were packed unilaterally with a 5.5 cm anterior Rapid

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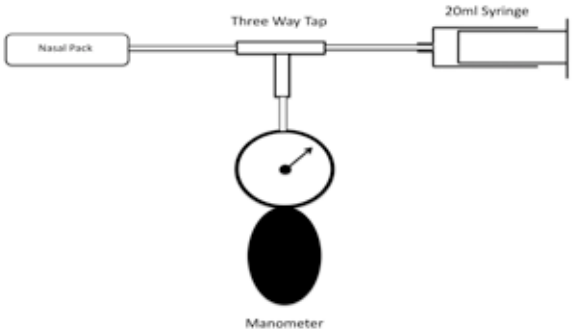

Figure 1. The intra-nasal pack pressure was measured using a manometer connected to a 10 ml syringe via a 3-way tap.

Rhino® pack (using the standard technique as described by the manufacturers) [4] 10 minutes after topical nasal preparation with co-phenylcaine (5% lignocaine and 0.5% phenylephrine) spray. The intra-nasal pack pressure was measured using a manometer connected to a 10 ml syringe via a 3 way tap using standard green oxygen tubing (see Figure 1). The volume inflated was increased from 2.5 ml to 12.5 ml in 2.5 ml increments and the resultant intra-nasal pack pressure was measured at each volume. Pack inflation was stopped if uncomfortable for the subject.

RESULTS

For inflation volumes of 2.5 ml, 5 ml, 7.5 ml, 10 ml and 12.5 ml, the mean intra-nasal pressures achieved were 24 mmHg, 65 mmHg, 101 mmHg, 137 mmHg and 179 mmHg, respectively. The maximum intra-nasal pack pressure measured after 12.5 ml of air inflation was 213 mmHg. All subjects tolerated the maximal inflation volume of 12.5 ml without significant discomfort.

Figure 2 shows the results for all 12 subjects displayed as line graphs. It can be observed that within the range of volumes measured, the nasal pack inflation volume and pressure appear to have a linear relationship for most subjects. However, for a given inflation volume, the pressure generated varied greatly between different individuals. This large variation between some individuals can be demonstrated by the comparison of subject 11, who reached 136 mmHg with only 7.5 ml of air inflated, with subject 1 who reached only 128 mmHg even after the maximum 12.5 ml of air was inflated.

Figure 3 displays the average intra-nasal pack pressure for all subjects at each inflation volume. This graph shows that at higher inflation volumes there is greater variance of intra-nasal pressures between individuals.

DISCUSSION

This study provides new information describing the relationship between inflation volume and resultant intra-nasal pack pressure when using balloon nasal packing devices. There are however some weaknesses to our study.

Our sample population included only young healthy individuals without significant nasal structural abnormalities. This study group may not be representative of the epistaxis population who may have structural nasal deformities and are likely to be considerably older. In addition, it is not always possible to adequately prepare the nose with co-phenylcaine when packing patients in the acute setting. This may reduce the level of decongestion achieved in these patients, thereby reducing the intra-nasal volume. This could affect the pressure / volume relationship when comparing the epistaxis population with our sample population who were all well decongested prior to pack insertion. It is interesting to note that in our study, all subjects tolerated the maximum measured inflation volume of 12.5 ml, however, this might not be the case in patients who have not had adequate nasal anaesthetic/decongestant preparation.

Although our sample size is small, it is clear that there is a large amount of variation between individuals regarding the intra-nasal pack pressure produced by inflation of a fixed volume of air. We would hypothesise that this is due to natural variation in intra-nasal anatomy volume between individuals. This large variation means it is difficult to derive a mathematical representation of the pressure/volume relationship. If the nasal cavity were thought of as a fixed bony cavity (as the cranium is) then one would expect an exponential shaped graph to describe the pressure/volume relationship. This does not appear to be the case with our results, which shows a roughly linear relationship between pressure and volume for the range of volumes tested. This linear relationship may be explained by the theory that with increasing pack volume and pressure, the mucosa of the nasal cavity is compressed and the turbinates and septum are displaced allowing for some conformation and accommodation of volume expansion. Alternatively the pack may be expanding into the post nasal space, although the shape of the pack is designed to prevent this.

It has been observed by the authors that junior doctors often ask how much air to inflate into nasal balloon packs when managing epistaxis. This question is sometimes answered with the advice that a fixed inflation volume should be used as suggested by the advising senior clinician, based on their previous experience, with advice to increase this if epistaxis continues. Alternatively, advice is given that the pack should be inflated until the cuff 'feels firm'. This second technique is consistent with the manufactures instructions for use [4].

There are, however, no studies, which have described the nasal balloon pack pressures associated with the pilot cuff 'feeling firm'. The use of pilot cuff palpation to estimate internal cuff pressure has been shown to be an inaccurate method of measurement when used in the setting of tracheostomy and endotracheal tube balloon cuff pressures. Due to the concern regarding injury to the trachea it has been suggested that best

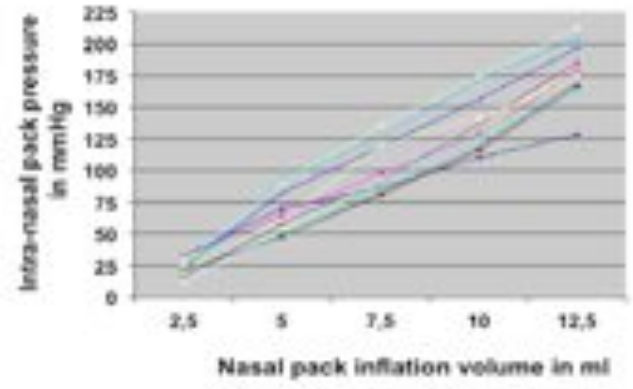

Figure 2. Results for all 12 subjects displayed as line graphs: Nasal Pack Volume vs Pressure.

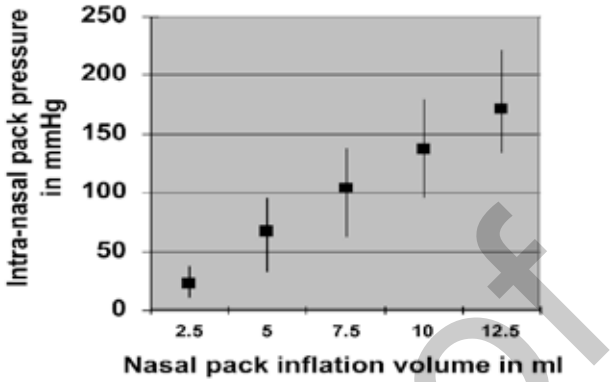

Figure 3. The average intra-nasal pack pressure for all subjects at each inflation volume with ± 2 standard deviations error bars shown as a measure of variance.

practice is to regularly measure tracheostomy tube cuff pressures with a manometer [5].

Inaccurate estimation of nasal pack balloon inflation pressures could lead to failure to achieve haemostasis from under inflation, but more importantly unnecessary over inflation could result in excessive pain, the possibility of structural injury [7], or most worryingly cardio-respiratory complications due to vagal stimulation [8].

We know from previous studies that when nasal balloon packs are inflated, the initial pressure produced is not sustained and often falls by more than 50% of which most of this occurs over the first 20 to 30 minutes after pack insertion (when examined in post septoplasty patients) [9]. This study also showed that this depressurisation was not due to deflation. This depressurisation must be due to a more gradual conformation of the nasal cavity with sustained pressure over a longer period. This may explain why some patients re-bleed at a delayed point some time after initial packing.

Regular use of manometers to measure balloon nasal pack pressures would allow for nursing staff to monitor the pressure with possible scope for re-inflating up to a prescribed cuff pressure if required. The improvised manometer used in our study is quick and easy to construct. It uses a standard ward sphygmomanometer connected to a three way tap with standard oxygen tubing and could be adopted easily on all ENT wards with minimal cost.

The study by Smyth et al. gives us some idea about the pressures required to achieve haemostasis although it should be noted that these were all patients who were packed immediately following nasal surgery rather than patients with epistaxis de novo. The inflation pressure for most of these patients was stated as being between 30-60 cmH_2O, which is equivalent to 22 – 44 mmHg. This gives us a guide as to what is likely to be an appropriate initial inflation pressure but further research needs to be done to determine the optimal pack pressures to be used in the management of epistaxis. This information would be important in supporting the routine use of manometer-measured, pressure-guided balloon nasal pack inflation.

CONCLUSION

Recent research has shown that inflatable balloon nasal packing devices are probably more comfortable for patients than more traditional nasal tampons and may also be better for reducing re-bleeding on pack removal. This may lead to their more widespread use as they become regarded as best practice for the management of uncontrolled epistaxis. Despite this, there is no clear guidance on how much air to inflate, nor any data on which to base this advice.

We know from other studies that clinicians are not good at judging pilot cuff pressures by palpation. Our study shows that a 'one volume fits all' approach to pack inflation is not appropriate due to the large variance in intra-nasal pack pressures produced in different individuals for a given fixed volume. The authors would therefore advocate a move towards training junior doctors to directly measure pack pressures with a manometer with the potential to training ENT nursing staff to monitor/maintain pack pressure to prevent unwanted depressurisation (and possible re-bleeding). In order for this to become common practice, further research is needed to quantify the optimum pressures required to achieve haemostasis in epistaxis whilst minimising patient discomfort levels.

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