Review Article

A systematic review of the effectiveness and complications of using nasal bridles to secure nasoenteral feeding tubes

Angelica Lynch[1], Cheryl S. Tang[2], Luxmana S. Jeganathan[3], Jason G. Rockey[2]

[1]Queensland Health, Australia; [2]Bendigo Health, Bendigo, Australia; [3]Northern Health, Melbourne, Australia

Contributions: (I) Conception and design: CS Tang, LS Jeganathan, JG Rockey; (II) Administrative support: A Lynch; (III) Provision of study materials or patients: CS Tang, LS Jeganathan, JG Rockey; (IV) Collection and assembly of data: CS Tang, LS Jeganathan, JG Rockey; (V) Data analysis and interpretation: CS Tang, LS Jeganathan, JG Rockey; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Angelica Lynch. Logan Hospital, Armstrong Rd and Loganlea Rd, Meadowbrook QLD 4131, Australia. Email: angelica.lynch@griffithuni.edu.au.

Abstract: Systematic literature review regarding efficacy and complication rates of securing nasoenteral tubes with nasal bridles. Studies included: systematic reviews, randomized controlled trials or comparative studies comparing nasal bridles with one or more other method of securing nasoenteral tubes. No restriction on age, language, year of publication or methodology quality was imposed. 18 studies were included. Data extraction was conducted by one reviewer and verified by another. Outcomes evaluated included: rate of tube dislodgement, rate of tube replacement, tube dwelling time, quantified enteral nutrition, cost, complications, and PEG-related morbidity/mortality. Nasal bridling is associated with lower tube dislodgement rate, lower replacement rate and increased length of time of tube *in situ*, resulting in better delivery of nutrition via nasoenteral tubes secured with nasal bridles compared to conventional methods. However, there is higher incidence of epistaxis/nasal ulceration with nasal bridling compared to conventional methods. Nasal bridle is an easily inserted device that improves nasoenteral tube dwelling time and, subsequently, ability to deliver optimal nutrition.

Keywords: Gastrointestinal; intubation; enteral; review; effectiveness; morbidity

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Introduction

Unplanned removal of feeding tubes consumes resources and exposes patients to an increased risk of complications. Some of these complications are potentially fatal and mainly occur at the time of reinsertion of the nasoenteral tube itself. These complications can be averted by preventing dislodgement of the tube. Several methods of securing nasoenteral tubes have been developed over time. A range of adhesive tapes, septal sutures, nasal bridles and even football helmets (1) have been used to anchor nasoenteral tubes. There is increasing evidence showing that nasal bridles are effective at preventing tube dislodgement and may hence reduce complication rates.

Nasal bridles have been described since 1989 (2). A bridle is a length of material that enters one naris, loops around the nasal septum and exits the opposite naris. Today, there are two main techniques of creating a bridle. The ends of spare material are passed through each naris, retrieved through the oropharynx and tied to form a loop. The loop is then pulled from one of the naris, shortened and the ends tied again to form the bridle. This technique requires a physician to safely insert the bridle. The other technique makes use of the Applied Medical Technology (AMT) bridle© (Pro-Care Ltd, UK), a device that uses a magnetic retrieval system to aid the formation of the bridle around the nasal septum (3). It has been shown to be a simple, fast system that does not require specialized equipment and can be safely performed by nurses at the bedside (3).

Despite the advent of this simple device, bridling is still generally used only for high-risk patients or those in whom replacing the tube is deemed to be dangerous. Its limited

use is likely due to a perceived increased risk of posterior epistaxis, stimulation of microbial growth that may promote sinusitis, major septal injury and patient discomfort. We conducted a systematic review to evaluate the efficacy and complication rate of nasal bridle compared to conventional methods.

Materials and methods

We searched for published and unpublished articles in June 2014 in seven electronic databases (MEDLINE, EMBASE, CINAHL, SCOPUS, the Cochrane Library, ProQuest Dissertations and Theses Global and Australasian Medical Index). The terms used were "nasal", "bridle", "loop", "nasoenteral", "nasogastric", "nasojejunal", "tube", "secure" and "retain". We searched for ongoing trials on Clinicaltrials.gov, WHO trial register and Cochrane DARE. We hand searched three journals (*Critical Care Medicine*, *Journal of Parenteral and Enteral Nutrition and Nutrition in Clinical Practice*) from 2004 to 2014, including articles only published online. We also hand searched abstracts from three conferences: Digestive Disease Week (2004–2014), American College of Gastroenterology Annual Scientific Meeting (2004–2014) and Clinical Nutrition Week (2010–2014). We contacted the manufacturer AMT and experts for relevant articles and ongoing research. We then searched the reference lists of the studies. If full texts of identified studies could not be readily obtained from online libraries, librarians, editors and identified contact person of relevant journals, publishers, manufacturers and authors were contacted for a copy of the missing articles. We also conducted a thorough search on the search engine Google for potentially available texts of the missing articles online.

Two reviewers independently screened titles and abstracts against the inclusion criteria. Any disagreements were resolved by discussion. Full texts of citations that met or could potentially meet the inclusion criteria were retrieved. These full texts were independently reviewed by two reviewers and discrepancies were resolved by consensus. Studies were included if they were systematic reviews, randomized controlled trials and comparative studies that compared nasal bridles with one or more other method of securing nasoenteral tubes. We excluded case reports, narrative reviews, editorial, letters, expert opinions and comments. Case series were included if direct comparisons were made before and after bridling. Case series were otherwise excluded. No restriction on age, language, year of publication or methodology quality were imposed.

Two reviewers independently appraised the quality of the study by using the validated Cochrane Collaboration's tool for assessing risk of bias. Any discrepancies were resolved by consensus. For each included study, data extraction was conducted by one reviewer and verified by another. Discrepancies were resolved by consensus. The outcomes evaluated were rate of tube dislodgement, rate of tube replacement, tube dwelling time, quantified enteral nutrition, cost, complications including emotional distress, and PEG-related morbidity and mortality. Extracted data was entered into a form that included characteristics of the study and outcomes measured. This form was initially trialed on ten random included studies. Relevant changes were made. The form was then deployed for all studies.

Results

Results of search

During the primary search, 2,750 titles and abstracts were screened, and 53 potential studies were identified based on the inclusion and exclusion criteria. Of these 53 studies, 15 were included in this study and the full texts of two could not be obtained. Six potential further studies were identified from the secondary search. After reviewing the full texts against the inclusion criteria, three were included and one excluded. The full texts of the other two studies could not be sourced. Of the missing texts, two are from discontinued journals, one is an abstract from a 1980 conference and one is from a European journal.

Characteristics of included study

A total of eighteen studies were included in this review (*Tables 1,2*). Only two of these were randomized controlled trials (4,5). One was a meta-analysis (6) and one was a systematic review (7). Each study was reviewed for risk of bias (*Table 3*). Data from >1,038 patients were included. One study (8) did not report the number of patients included in the study. Five studies (3-5,9,10) compared nasal bridles to adhesive tape while only two (11,12) compared bridling to septal sutures. Nine studies (8,13-20) did not specify which method was used for the control group or before nasal bridling was deployed. The meta-analysis (6) compared bridling to adhesive tape only. The systematic review (7) aimed to include any article that compared at least two methods of securing nasoenteral tubes. Only one (8) of the included eighteen studies was conducted in a pediatric

Table 1 Characteristics of included studies

Author, year	Intervention	Sample size	Study design	Study population
Beavan *et al.* [2010]	Bridle *vs.* adhesive tape	104	Randomized controlled trial	Dysphagic stroke patients requiring artificial feeding
Hegazi *et al.* [2008]	Bridle (control not specified)	74	Historically controlled	Patients who were referred to the Gastrointestinal Nutrition Support Service for nasojejunal feeding tube insertion at a tertiary centre
Brandt and Mittendorf [1999]	Bridle (control not specified)	66	Retrospective cohort	Patients who underwent endoscopic insertion of nasojejunal tubes in the surgical or burn intensive care unit
Al-Hussaini *et al.* [2014]	Bridle *vs.* anterior septal suture	10	Animal model	Cadaveric sheep
Cheung *et al.* [2009]	Bridle (control not specified)	48	Retrospective case series	In-patients referred for nasal bridle placement (reasons not specified)
Donaldson *et al.* [2007]	Bridle (control not specified)	96	Historically controlled	In-patients requiring nutritional support through nasoenteral tubes
Power *et al.* [2010]	Bridle (control not specified)	28	Case series	Patients who were deemed likely to benefit from nasal bridle placement due to high risk of feeding tube dislodgement
Bechtold *et al.* [in print]	Meta-analysis of bridle *vs.* tape	6 studies	Meta-analysis	Studies that compared the effectiveness of nasal bridles to adhesive tape
Seder *et al.* [2010]	Bridle *vs.* adhesive tape	80	Randomized controlled trial	In-patients of the surgical intensive care unit requiring nasojejunal feeding
Anderson *et al.* [2004]	Bridle (control not specified)	14	Prospective case series	Dysphagic stroke patients referred for percutaneous endoscopic gastrostomy placement
Johnston *et al.* [2008]	Bridle (control not specified)	53	Prospective cohort	Patients referred for nasal bridle placement (reasons not specified)
Parks *et al.* [2013]	Bridle *vs.* adhesive tape	50	Historically controlled	In-patients of the specialty burn unit with a burn or toxic epidermal necrolysis diagnosis and requiring nasoenteral feeding
Seder and Janczyk [2008]	Bridle *vs.* adhesive tape	234	Historically controlled	In-patients of the surgical intensive care unit at the time of nasoenteral tube placement
Lang *et al.* [2010]	Bridle (control not specified)	12	Prospective case series	Stroke and elderly patients receiving nasoenteral nutritional support who were referred for bridling due to tube dislodgement
Al-Khudari *et al.* [2010]	Bridle *vs.* septal suture	79	Prospective cohort	Patients who underwent head and neck surgery and required nasoenteral feeding post-operatively
Brugnolli *et al.* [2014]	Systematic review of devices used to secure NGTs	5 studies	Meta-analysis	Studies that compared at least two methods of securing nasoenteral tubes
Hardy *et al.* [2012]	Bridle (control not specified)	Unknown	Historically controlled	Paediatric burn patients requiring nasoenteral nutritional support
Gunn *et al.* [2009]	Bridle *vs*. tape	90	Prospective quality improvement project	Patients referred to the Enteral Access Team for nasoenteral tube placement

Table 2 Summary of quality appraisal of included studies

Author, year	Sample size	Study Design	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Beavan *et al.* [2010]	104	Randomized controlled trial	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Hegazi *et al.* [2008]	74	Historically controlled	High risk	High risk	High risk	Unclear risk	High risk	Low risk	Unclear risk
Brandt and Mittendorf [1999]	66	Retrospective cohort	High risk	High risk	Unclear risk	Unclear risk	Low risk	Low risk	Low risk
Al-Hussaini *et al.* [2014]	10	Animal model	Unclear risk	Unclear risk	High risk	Unclear risk	Low risk	Low risk	Low risk
Cheung *et al.* [2009]	48	Retrospective case series	High risk	High risk	High risk	Unclear risk	Unclear risk	Unclear risk	Unclear risk
Donaldson *et al.* [2007]	96	Historically controlled	High risk	High risk	High risk	Unclear risk	Unclear risk	Low risk	Unclear risk
Power *et al.* [2010]	28	Case series	High risk	High risk	High risk	High risk	Low risk	Low risk	Low risk
Bechtold *et al.* [in print]	6 studies	Meta-analysis	–	–	–	–	–	–	–
Seder *et al.* [2010]	80	Randomized controlled trial	Low risk	Low risk	High risk	Unclear risk	Low risk	Low risk	Low risk
Anderson *et al.* [2004]	14	Prospective case series	High risk	High risk	High risk	Unclear risk	Low risk	Low risk	Low risk
Johnston *et al.* [2008]	53	Prospective cohort	High risk	High risk	High risk	Unclear risk	Low risk	Low risk	Low risk
Parks *et al.* [2013]	50	Historically controlled	High risk	High risk	High risk	Unclear risk	Low risk	Low risk	Low risk
Seder and Janczyk [2008]	234	Historically controlled	High risk	High risk	High risk	Unclear risk	Low risk	Low risk	Low risk
Lang *et al.* [2010]	12	Prospective case series	High risk	High risk	High risk	Unclear risk	Unclear risk	Unclear risk	Unclear risk

Table 2 *(continued)*

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Author, year	Sample size	Study Design	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Al-Khudari *et al.* [2010]	79	Prospective cohort	Unclear risk	Unclear risk	High risk	Unclear risk	Low risk	Low risk	Unclear risk
Brugnolli *et al.* [2014]	5 studies	Meta-analysis	–	–	–	–	–	–	–
Hardy *et al.* [2012]	Unknown	Historically controlled	High risk	High risk	High risk	Unclear risk	Unclear risk	Low risk	Unclear risk
Gunn *et al.* [2009]	90	Prospective quality improvement project	High risk	High risk	High risk	Unclear risk	Low risk	Low risk	Low risk

cohort.

Nasoenteral tube dislodgement

Eight studies reported a significant decrease in nasoenteral tube dislodgement with bridling than with conventional methods (3,4,9,10,13,14,17,18,). Similarly, two studies (5,9) reported that nasal bridling significantly decreased the rate of tube replacement. A meta-analysis of five studies by Bechtold *et al.* reported dislodged tubes in 14% of the patients in the bridle group compared to 40% in the adhesive tape group (OR 0.16, 95% CI: 0.10–0.27, P<0.01) (6).

Carey *et al.* compared the weight required to dislodge nasogastric tubes secured with anterior septal sutures and nasal bridles in cadaveric sheep (11). If secured by a septal suture, the nasogastric tube would sustain a weight of 4.5 kg, distort at 5 kg, and snap with a 5.5 kg weight. Bridled tubes were consistently intact up to a weight of 15.5 kg. At 16 kg, the nasogastric tube itself snapped, leaving the bridle intact. No damage to the septum was observed.

In-dwelling time

Four studies reported nasoenteral tubes secured with nasal bridles remaining *in situ* for significantly longer than conventional methods (3,4,14,20). One study compared nasal bridles to septal sutures and did not find a statistically significant difference in tube dwelling time (12).

Delivery of targeted nutrition

Five studies (4,5,15,16,18) evaluated the effect of nasal bridling on the proportion of prescribed feed delivered to patients via nasoenteral tubes. All five studies reported that feed delivery significantly increased with the use of bridles.

Imaging

The effect of nasal bridling on the number of radiographs performed was assessed by two studies (5,9). Both observed that nasal bridling significantly reduced the number of radiographs done.

Cost

Only two studies evaluated the impact of nasal bridling on cost. Beavan *et al.* found mean cost per patient was higher in the bridle group (£426 *vs.* £338) (5). This was

Table 3 Summary of results of included studies

Author, year	Intervention	Sample size	Results
Beavan *et al.* [2010]	Bridle *vs.* adhesive tape	104	Tube replacement and Chest X-rays: median number of tubes replaced and chest X-rays required were lower in the bridle group compared to the control
			Feed delivery: delivered prescribed nasoenteral feeding was 17% (95% CI: 5–28%, P=0.002) greater in the bridle group. 16,994 (95% CI: 14,323–19,665) mL in bridle group; 11,367 (95% CI: 8,935–13,799) mL in control group
			Nasal bleeds, pressure areas or nasal discharge: 19/51 (37%) patients in bridle group; 8/53 (15%) patients in control group
			Discomfort: 12/43 (28%) in the bridled cohort experienced day-to-day discomfort compared to 17/41 (41%) in the control group
			Distress: 19/43 (44%) and 16/41 (39%) patients in the bridle and control group respectively reported the placement of the feeding tube was distressing
			Mortality and morbidity: no significant difference in rate of death and Barthel Index <12 at 3 months. 41/51 (80%) patients in the bridle arm vs. 47/53 (89%) patients in the conventional cohort (P=0.7)
			Cost: 426 pounds per patient over 2 weeks in the bridle group; 338 pounds in the control group. This was attributed to an estimated 5.20 pounds increment per extra percent of prescribed feed delivered
Hegazi *et al.* [2008]	Bridle (control not specified)	74	Tube dislodgement: 12/37 (32%) in bridle group; 23/37 (62%) in conventional group
			Nasal ulcers: 7/37 (19.5%) in bridle group; 1/37 (2.7%) in conventional group
Brandt and Mittendorf [1999]	Bridle (control not specified)	66	Tube dislodgement: 1/24 (4%) patients in bridle group; 16/48 (38%) patients in control group
			Tube dwelling time: median 23.0 days in bridle group; 16.0 days in control group
Al-Hussaini *et al.* [2014]	Bridle *vs.* anterior septal suture	10	Using sheep heads, demonstrated that nasogastric tubes secured with bridles were consistently able to sustain a weight of 15.5 kg before snapping compared to 4.5 kg when secured with anterior septal sutures
Cheung *et al.* [2009]	Bridle (control not specified)	48	Feed delivery: number of days when feed delivery was <50% of prescribed feed was 298 of 443 (67.3%) total patient days before bridling; this decreased to 168 of 1,256 (13.4%) patient days after bridle insertion
			Complications: no significant complications observed
Donaldson *et al.* [2007]	Bridle (control not specified)	96	Feed delivery: prescribed nutrition delivered increased from 20% to 98% after routine bridling was implemented
			Mortality: 16% percutaneous endoscopic gastrostomy related mortality fell to 6% after routine bridling was instituted
Power *et al.* [2010]	Bridle (control not specified)	28	Tube dislodgement: 93 feeding tubes secured with conventional were dislodged in 28 patients. This decreased to a total of only 4 dislodgements after using nasal bridles in these 28 patients
			Epistaxis: minor epistaxis in 6/28 (21%) patients during insertion of bridle

Table 3 *(continued)*

Table 3 *(continued)*

Author, year	Intervention	Sample size	Results
Bechtold *et al.* [in print]	Meta-analysis of bridle *vs.* tape	6 studies	Tube dislodgement: 28/203 (14%) patients in bridle group; 138/341 (40%) in control group (Odds ratio: 0.16, 95% CI: 0.10–0.27, P<0.01, analysis of 5 studies)
			Skin irritation or ulceration: 20/156 (13%) patients in bridle group; 9/282 (3%) of tape group. (Odds ratio: 4.27, 95% CI: 1.79–10.23, P<0.01, analysis of 4 studies)
			Sinusitis: 0/57 (0%) patients in bridle cohort; 4/73 (5%) in tape group (analysis of 2 studies)
Seder *et al.* [2010]	Bridle *vs.* adhesive device	80	Tube dislodgement: 7/40 (18%) patients in bridle group; 25/40 (63%) patients in control group (P<0.0001)
			Feed delivery: % of caloric goal achieved was a median of 78 (interquartile range: 65, 86) in bridle group and 62 (interquartile range: 47, 80, P=0.016) in the control group
			Tube dwelling time: median 9 (interquartile range: 3, 18) days in bridle group; 6 (interquartile range: 3, 13, P=0.21) days in the control group
			Nasal ulceration: 4/40 (10%) patients in bridle group; 0/40 (0%) in control group (P=0.12)
			Sinusitis: 0/40 (0%) patients in bridle group; 2/40 (5%) patients in control group (P=0.49)
Anderson *et al.* [2004]	Bridle (control not specified)	14	Tube replacement and dislodgement: median of 4 (range: 2–7) tube replacements before bridling. 2/14 (14%) patients dislodged their tube within 24 hours of bridling but these were not replaced
			Feed delivery: median was 0% (range: 0–47) before bridle insertion. This increased to 100% (range: 0–100) post bridling
			Complications: of 14 patients, 2 developed pneumonia and 1 complained of nasal discomfort which resulted in the removal of the nasal bridle
Johnston *et al.* [2008]	Bridle (control not specified)	53	Epistaxis: minor epistaxis in 3/45 (7%) patients during bridle insertion
			Mortality: mortality related to percutaneous endoscopic gastrostomy fell from 28% to 11% after implementation of routine nasal bridling
Parks *et al.* [2013]	Bridle *vs.* adhesive tape	50	Tube replacement: mean number of feeding tube insertion was 0.26 (standard deviation 0.23) per tube day in bridle group compared to 0.44 (standard deviation 0.34) for the control group
			Abdominal X-rays: an estimated 3.3 times higher abdominal radiographs per tube day in the control group compared to the bridle group
			Complications: no significant difference in rate of complications observed
Seder and Janczyk [2008]	Bridle *vs.* a dhesive tape	234	Tube dislodgement: 4/62 (6.5%) in bridle group; 56/172 (32.6%) in tape group (P<0.0001)
			Nasal ulceration: 4/62 (6.5%) had external nasal ulceration in nasal bridle group. This was attributed to using 8-Fr red rubber catheter for the bridle. No further occurrence of nasal ulceration was observed when the bridle material was changed to umbilical tape.
			Cost: estimated savings of $4,038 over the 3 months study period.
Lang *et al.* [2010]	Bridle (control not specified)	12	Tube dwelling time: mean number of whole days with feeding tube remaining in situ was 3.3 (range, 0.0–14.0) with bridle compared to 1.0 (range, 0.3–4.0) before bridle insertion (P=0.061)
			Epistaxis: 4/12 (33%) patients experienced minor epistaxis upon insertion of bridle

Table 3 *(continued)*

Table 3 *(continued)*

Author, year	Intervention	Sample size	Results
Al-Khudari *et al.* [2010]	Bridle *vs.* septal suture	79	Tube dwelling time: <5 days for 13 patients, <9 days for 26 patients and >10 days for 6 patients in bridle group. <5 days for 1 patient, <9 days for 18 patients and >10 days for 10 patients in suture group
			Pain: no significant difference in overall pain between bridling and septal sutures. Pain secondary to securing method was significantly less with bridling up to 9 days post tube insertion (P<0.05)
Brugnolli *et al.* [2014]	Systematic review of devices used to secure NGTs	5 studies	Concluded that no specific method of securing feeding tubes could be advised over another
Hardy *et al.* [2012]	Bridle (control not specified)	Unknown	Tube dislodgement: dislodgement rate fell from 19% to 7% after implementation of routine nasal bridling
			Complications: no pressure sores observed during period of study
Gunn *et al.* [2009]	Bridle *vs.* tape	90	Tube dislodgement: 4/40 (10%) patients in bridle group; 18/50 (36%) patients in tape group
			Tube dwelling time: Kaplan-Meier analysis showed "survival" of tube was significantly greater with bridling (log-rank test for equality of survivor function of P<0.05)
			Epistaxis: 1 episode of epistaxis in the bridle group; 0 in the control group

attributed to the use the AMT bridle© (Pro-Care Ltd, UK) which cost £76 each and an estimated £5.20 increment per extra percent of prescribed feed delivered. However, Seder and Janczyk estimated they saved $4038 over the 3-month study period (10). They fashioned nasal bridles themselves using 8-Fr red rubber catheter and, later, 1/8-inch umbilical tape. The bridles cost only $6 per patient. The $4,038 savings was calculated by estimating how many replacements were avoided. This was an estimated 16 nasoenteral tube replacements during the study period. Two of these sixteen would have likely required fluoroscopy which costs $875 each.

Complications

Five studies (3,5,17,19,20) reported a higher incidence of self-limiting episodes of epistaxis with bridling, mostly due to insertion of the bridle itself. Seven studies evaluated the incidence of nasal ulceration and other superficial complications. Three (4,10,13) reported a higher incidence in the bridle group, three (5,8,9) observed no significant difference with either method and the last was a meta-analysis (6) of 4 studies. The later meta-analysis found 13% of patients with nasal bridles had skin complications compared to 3% of the adhesive tape group (OR 4.27, 95% CI: 1.79–10.23, P<0.01). Seder et Janczyk observed that nasal ulceration was secondary to using 8-Fr rubber catheter and no further incidence was documented when the rubber catheter was substituted by 1/8-inch umbilical tape (10).

No study reported any significant injury secondary to a dislodged tube attached to a bridle. Two studies (4,9) compared the incidence of sinusitis and both reported two cases of sinusitis with conventional methods and none in the bridle group.

Pain and distress

Only two studies assessed the impact of nasal bridling on pain or distress. Beavan *et al.* (5) reported 19 of 43 (44%) patients in the bridle arm and 16 of 41 (39%) patients in the control group found the insertion of NGT distressing. In the same study, 12 (28%) and 17 (41%) in the bridled and control group respectively experienced day-to-day discomfort. Al-Khudari *et al.* (12) observed that overall pain did not differ significantly between bridling and septal sutures. However, up to 9 days post tube insertion, pain secondary to the securing method itself was significantly less with bridling (P<0.05) but was not statistically different

after 10 days (P=0.7).

Mortality and morbidity post-acute stroke

Two studies (16,19) reported 30 day-mortality post PEG insertion fell after routine bridling was introduced. On the other hand, Beavan *et al.* concluded that, in a cohort of patients with severe dysphagia post acute stroke, the outcomes were similarly poor in both the conventional and bridled arms (5).

Discussion

We conducted this systematic review to evaluate the effectiveness and complications of securing nasoenteral tubes using nasal bridles. We found that nasal bridling was associated with a lower rate of tube dislodgement, higher percentage of targeted feed received, decreased use of imaging and, potentially, decreased costs and distress to the patient compared to conventional methods of securing nasogastric tubes. However, there was a higher incidence of minor nasal complications but no significant increase in major complications such as posterior epistaxis, sinusitis or substantial trauma to the septum. Overall, we found that the nasal bridle is a safe and effective method of securing nasoenteral tubes.

Enteral feeding is associated with a lower complication rate, attenuated inflammatory responses and shorter recovery time (21-23). Villet *et al.* showed that, in intensive care patients, a higher proportion of delivered prescribed nutrition decreased infection rate, length of mechanical ventilation and length of stay in intensive care unit (24). Nasal bridling reduces tube dislodgement rates and, hence, increases the reliability of feeding via enteral tubes. This suggests that nasal bridling can improve complication rates and patient outcomes by ensuring sustained feeding of patients.

Reducing dislodgement rates also means a lower rate of tube replacement. This, in turn, decreases the exposure of individual patients to the procedural risks of enteral tube placement. The risk of complications from nasoenteral tube insertions has been reported to be as high as 20% (25). The most common are endotracheal intubation and aspiration pneumonia but intraperitoneal, intravascular, mediastinal and intracranial intubation have also been reported (25). All of these complications are potentially fatal and can be avoided by decreasing the risk of tube dislodgements with the routine use of nasal bridles.

A lower rate of nasoenteral tube replacement may also decrease patient and staff's distress. Beavan *et al.* reported that distress or perceived distressed secondary to insertion and replacement of nasogastric tube was reported by nearly 40% of the patients or their nurse (5). Further, nearly 85% of patients included in the study had cognitive impairment and were unable to give consent for the procedure. This suggests a significant number of patients, particularly stroke patients, have a limited understanding of the need for enteral tube insertions and their replacement if dislodged. This may exacerbate the feeling of distress. Using nasal bridling to reduce the frequency of nasoenteral tube replacements may, hence, reduce distress of patients and contribute to a more positive patient experience.

The impact of bridling on cost was ambivalent. Seder and Janczyk (10) fashioned bridles themselves using rubber catheter or 1/8-inch umbilical tape which cost only $6 per patient, and potentially avoided 2 videofluoroscopy and 14 bedside replacements during the study period. This translated to an estimated total savings of $4,038. On the other hand, Beavan *et al.* reported higher costs in the bridle group (5). This was attributed to using the AMT bridle© (Pro-Care Ltd, UK) which cost £76 each and an additional £5.20 per extra percent of targeted nutrition delivered. This suggests that cost of implementing routine bridling depends on the population, frequency at which costly imaging are routinely performed for nasoenteral tube insertion such as videofluoroscopy and whether a device is used to fashion the bridle or it is done by a clinician using cheaper material.

Bridling was associated with a higher rate of minor nasal trauma but not major complications. The incidence of minor nasal trauma, such as minor epistaxis and mucosal ulceration, secondary to nasal bridles was inconsistent. Three out of six studies (5,8,9) did not observe more frequent minor nasal trauma with 1/8-inch umbilical tape bridles. This suggests that there may be other factors impacting on the incidence of these minor complications, such as ensuring the bridle is tension-free at the time of insertion and regular application of lubrication to reduce friction. Conversely, our review found no reported major complications, such as posterior epistaxis or septal injury, even if the nasoenteral tube was forcefully removed by patients. Despite a higher incidence of minor nasal complications, nasal bridles are overall safe devices for securing nasoenteral tubes.

It has been suggested that nasal bridling may reduce the rate of PEG insertion and its associated complications (16,19). Two studies (16,19) found that reliable feeding due to using nasal bridles allowed patients to recover their swallowing ability

and, hence, avoid PEG insertion. However, the randomized controlled trial by Parks *et al.* demonstrated that, in a population of acute stroke patients with high risk dysphagia, there was no significant difference in the rate of PEG insertion between the bridled and conventional group (9). The evidence is not sufficiently robust to conclude whether or not bridling may prevent PEG placement but it suggests that nasal bridling may avoid PEG placement in patients with mild to moderate dysphagia.

Our study had several limitations. Only 50% of the included studies reported the method used in the control group. This limited our ability to perform sub-group analysis and, particularly, evaluate how nasal bridling compared to septal sutures alone. The quality of the studies varied with only two being randomized controlled trials, potentially resulting in selection bias and overestimation of intervention effect. Most studies only followed the patients until the tube was dislodged or intentionally removed. Consequently, inferences on long-term benefits of nasal bridling should be made with caution.

Conclusions

Lowering the rate of nasoenteral tube dislodgement using nasal bridles has considerable benefits, including reliable enteral feeding, shortening recovering time and lowering complication rates. However, nasal bridling is associated with a higher rate of minor complications, particularly self-limiting epistaxis and nasal septal ulceration. Nonetheless, the substantial benefits of sustained nutrition far outweigh the minor complications due to nasal bridles.

Optimal feeding due to bridling of nasoenteral tubes may also allow dysphagic patients more time to recover swallowing and, hence, avoid PEG insertion. Further randomized controlled trials are required to evaluate this potential benefit and its impact on PEG-related morbidity and mortality. Further research in the paediatric population is needed to evaluate whether nasal bridles are effective and, more importantly, at what age they can be safely inserted in children.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/ajo.2018.01.01). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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