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RESEARCH ARTICLE



Efficacy of hypertonic (2.3%) sea water in patients with aspirin-induced chronic rhinosinusitis following endoscopic sinus surgery

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ABSTRACT

Background: Aspirin-induced chronic rhinosinusitis (CRS) is a severe progressive persistent disease, usually associated with nasal polyps (NPs).

Aim/objective: To compare effect of hypertonic (2.3% NaCl) sea water and isotonic 0.9% NaCl on symptoms and endoscopic findings in those patients in the period of 1 month after endoscopic sinus surgery (ESS).

Material and methods: This prospective, randomized study included 30 patients with aspirin-induced CRS undergoing ESS. Patients were divided into two groups of 15 subjects and one of the two nasal irrigation solutions was administered in each group. Intensity of 5 symptoms (nasal obstruction, nasal discharge/postnasal drip, facial pain/pressure, headache and trouble sleeping) and endoscopic findings were assessed during the 1st, 7th, 14th, 21st and 28th days after the nasal packs removal.

Results: We found significantly lower total symptom score (TSS) during the 7th ($p = .009$), 14th ($p = .003$), 21st ($p < .001$) and the 28th day ($p = .001$), lower total endoscopic score (TES) on the 21st ($p = .002$) and 28th day ($p = .001$), lower nasal obstruction, facial pain/pressure, headache and trouble sleeping, and lower nasal mucosal edema, nasal secretion and nasal crusting in patients treated by hypertonic sea water.

Conclusion and significance: Hypertonic sea water should be recommended douching solution in the early postoperative care of patients with aspirin-induced CRS.

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Aspirin; nasal polyps; nasal surgical procedures; postoperative care; sinusitis

Introduction

Aspirin-exacerbated respiratory disease (AERD) is a combination of chronic rhinosinusitis with nasal polyps (CRSwNPs), bronchial asthma and upper and lower airway reactions to the ingestion of acetylsalicylic acid (ASA), as well as other cyclooxygenase-1 (COX-1)-inhibiting non-steroid anti-inflammatory drugs (NSAIDs) [1,2]. The use of these medications causes the inflammation of the respiratory mucosa with strong infiltration of activated mast cells, eosinophils and basophils into the mucosal layer. These inflammatory cells secrete high amounts of cysteinyl leukotrienes, tryptase, histamine and eosinophilic enzymes that damage nasal epithelium and lamina propria [1]. The patients with AERD develop severe CRS with strong nasal mucosal edema and many small polyps originating bilaterally from the nasal cavity and paranasal sinuses [1,2].

Endoscopic sinus surgery (ESS) is beneficial in AERD management and evidences demonstrated improvement in sinonasal and asthma symptom severity and frequency, radiographic and endoscopic scores and quality of life after

surgery [3]. However, ESS usually is not sufficient and other treatment options including intranasal and systemic corticosteroids, avoidance of aspirin and other NSAIDs, and aspirin desensitization are necessary for disease control [1–4]. Postoperatively, intranasal corticosteroid administration is very important in slowing the recurrence of nasal polyps (NPs) [3]. There is no standardized approach to postoperative care of patients with CRS after ESS, but, based on the available evidence, use of standard topical steroid spray together with nasal saline irrigation and sinus cavity debridement are recommended as early postoperative care [5,6].

Nasal irrigation solutions with different contents are widely used treatment options in the early postoperative care after ESS. These solutions remove infective debris and crusts, accelerate mucosal healing and improve mucociliary clearance [5,6]. However, there is a lack of knowledge on efficacy of different nasal irrigation solutions in the postoperative care of patients with aspirin-induced CRS. The aim of this study was to compare the effects of hypertonic (2.3% NaCl) sea water and isotonic 0.9% NaCl solution on nasal

symptoms and endoscopic findings in patients with aspirin-exacerbated CRS in the period of 1 month after ESS.

Patients and methods

Participants

The adult patients with AERD undergoing bilateral endoscopic fronto-spheno-ethmoidectomy and polypectomy with the same extent of surgery were eligible for this randomized, double-blind, parallel arm and prospective-controlled study. All patients were operated on by the same surgeon using the same technique. In cases of significant septal deformities, some anatomical variations (e.g. concha bullosa of the middle turbinate), or mucosal hypertrophy of the inferior turbinate, the surgeon performed additional surgical procedures (septoplasty, lateral resection of the concha bullosa and submucosal reduction of hypertrophied mucosa). This investigation was conducted in our Department of Otorhinolaryngology between May 2016 and April 2018 in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The Ethics Committee of our institution approved the study protocol and we obtained written informed consent from each patient.

The diagnosis of CRSwNP was based on guidelines established by the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS 2012) [7]. The criteria for inclusion in this study were (a) the preoperative presence of bilateral NPs of minimum grade 2, according to NP grading system [8]; (b) the evidence of sinus disease on the preoperative CT scan; (c) more than one compelling history of a reaction to aspirin or other NSAIDs, presenting with upper and/or lower symptoms and (d) the diagnosis of mild persistent bronchial asthma by the same experienced pulmonologist according to GINA [9] criteria. All patients received asthma therapy including inhaled bronchodilators and inhaled corticosteroids as recommended by pulmonologist. The patients with moderate-to-severe bronchial asthma were excluded from the study.

The other exclusion criteria were younger than 18 and older than 65 years, the presence of choanal polyps, systemic diseases affecting the nose, pregnancy and lactation, current cigarette smoking, previous paranasal sinus surgery, the use of topical or systemic antibiotics, oral or topical corticosteroids and antihistamines and oral leukotriene antagonists within the 4 weeks before the surgery.

Preoperative symptom assessment, endoscopic and CT examination

The preoperative assessment of nasal symptoms, endoscopic findings and computed tomography (CT) findings were performed in all patients within 4 weeks before the surgical treatment. Intensity of 5 symptoms (nasal obstruction, nasal discharge/postnasal drip, facial pain/pressure, headache and trouble sleeping) was assessed by the patients using a visual analog scale (VAS) (0–10 cm; from 0 = absent to 10 = maximum intensity). We used preoperatively the

total symptom score (TSS, sum of the scores of five nasal symptoms).

Assessment of the NP size scores was performed in all patients in a sitting position with a rigid endoscope (0° and 30°). The NP size scores were made on the basis of endoscopic findings according to Lildholdt et al. [8] Maximum endoscopic score is six, bilaterally. The findings from the CT scans were evaluated in all patients according to the Lund–Mackay score [10].

Postoperative care

The nasal packing (cotton wool gauze packs with vaseline ointment) was put bilaterally in the nasal cavity in all patients after ESS. After that, all patients were discharged home with the recommendation to start with treatment by oral antibiotic cefuroxime, 500 mg film tablets, twice a day, for 5 days after surgery. On the fifth day, the nasal packing was removed in our outpatient department and the patient was instructed with the recommendation to start nasal irrigation. In the morning, the nasal lavage was recommended to be followed by topical steroid sprays mometasone furoate, 200 µg once daily (two puffs in each nostril in the morning). Patients were randomly divided into two groups of 15 subjects and one of the two nasal irrigation solutions was administered to each group. Both the participants and the investigators were blinded to which solution was used. Group 1 was administered hypertonic sea water (2.3% NaCl, composition NaCl 23.00 g/L, sulfates 2.30 g/L, magnesium 1.04 g/L, calcium 0.31 g/L, potassium 0.42 g/L, copper traces and zinc traces) and Group 2 was administered isotonic sodium chloride (0.9% NaCl). All patients were asked and instructed to use nasal washing fluids three times daily for a period of 28 days following the removal of the nasal packing. A total of 60 ml of solution was used for each nasal irrigation, with 30 ml for each nasal cavity.

Clinical evaluation (primary outcomes)

The patients were examined in the office on the 1st, 7th, 14th, 21st and 28th day after nasal packing removal. Intensity of five symptoms (nasal obstruction, nasal discharge/postnasal drip, facial pain/pressure, headache and trouble sleeping) was assessed by the patients at each visit, using a VAS. The patients recorded their symptoms on diary cards twice daily, in the morning and in the evening, and the same specialist recorded scores at the visits.

At each visit, the same rhinologist with proven experience in nasal endoscopy used a 4 mm 0° and 30° endoscope (Karl Storz Endoscope SE & Co, Tuttlingen, Germany) to evaluate the intensity of mucosal edema, nasal secretion and nasal crusting and he rated their local findings as follows: 0, none; 1, mild; 2, moderate; 3, moderately severe and 4, severe. The endoscopic findings were graded in a manner blinded to which group of patients were in.

The efficacy endpoints were mean TSS (sum of the scores for nasal symptoms), individual symptom score (score for each nasal symptom), total endoscopic score (TES; sum of

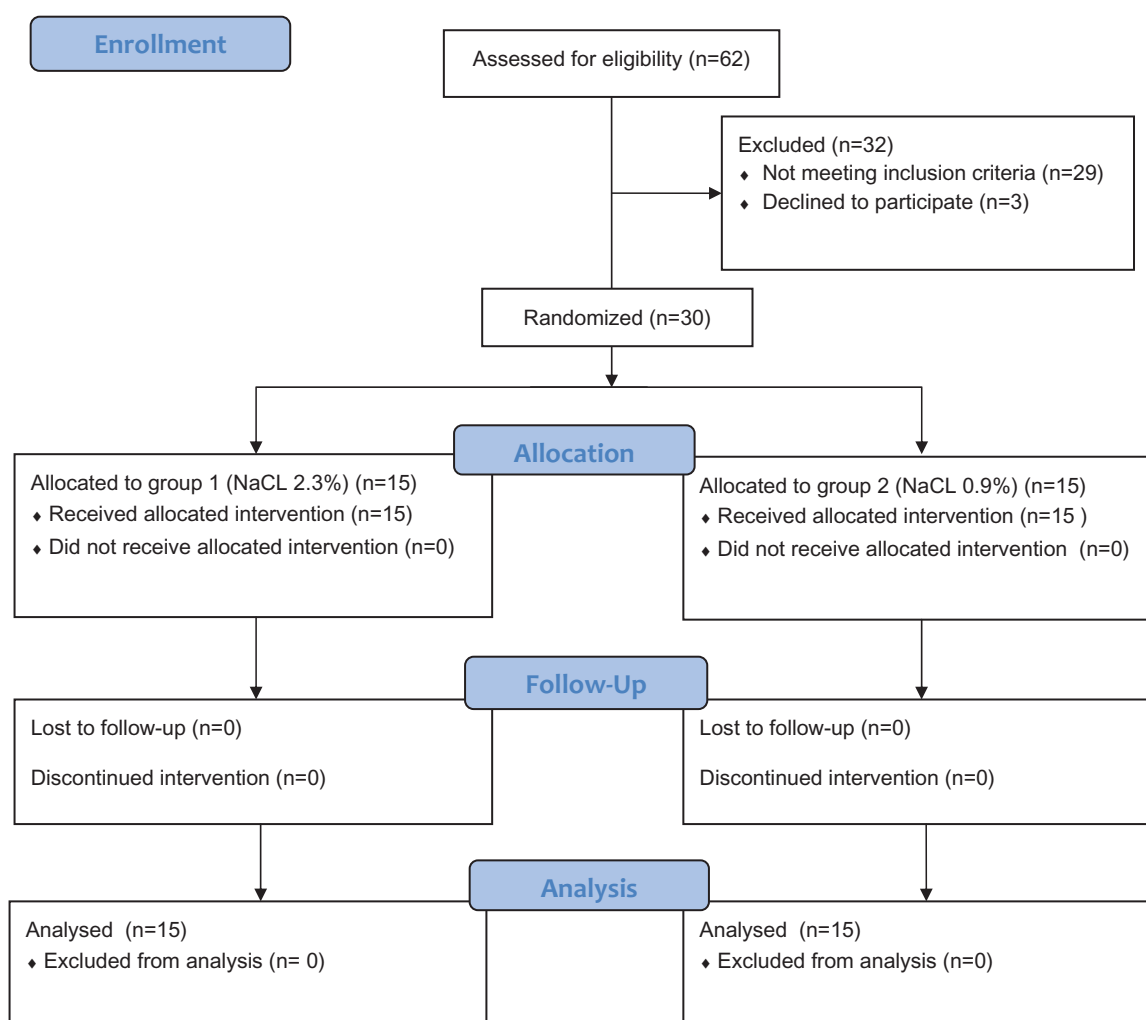


Figure 1. Trial profile (Flow Diagram), organized according to CONSORT statement. Sixty-two patients ($n = 62$) were involved to enter the study. Three ($n = 3$) refused to participate and twenty-nine ($n = 29$) patients not meeting inclusion criteria. Thirty ($n = 30$) patients were thus recruited and assigned to Group 1 ($n = 15$) and Group 2 ($n = 15$).

the endoscopic scores for each sign – mucosal edema, nasal secretion and nasal crusting), and individual endoscopic score for each local sign during the 1st, 7th, 14th, 21st and 28th day following the removal of nasal packs.

Potential adverse events

Reported adverse events were recorded throughout the study, with severity grades as mild, moderate and severe. The investigator queried all participants for any particular adverse events (nasal irritation, burning sensation and facial pain) during the 1st, 7th, 14th, 21st and 28th day after the removal of nasal packing.

Randomization

The randomization was performed in accordance with the CONSORT statement. We used a simple computer-generated randomization procedure to allocate the participants into groups. The participants were deemed eligible by the investigator who informed the nurse about the eligibility. The nurse then assigned the patient to Group 1 or 2 using a

computer-generated random allocation. There was no concealment of allocation because both groups used solutions (nasal washing fluids) which look alike and the participants could not know what they were using by simple inspection of the solution. The trial profile is presented in Figure 1.

Sample size and statistical analysis

We performed a power analysis that indicated that 15 patients would be required in each arm of the study to reach at least 80% power at 5% level of significance. Power calculation was based on a clinically relevant change for symptom scores and endoscopic scores of 1 point (interquartile range [IQR] 1). All eligible patients were randomized into Group 1 or 2. As we had the ordinary variables without the normal distribution, the parameters have been expressed as median with IQR. For between-group comparison of parameters (symptoms, TSS, signs and TES), during the 1st, 7th, 14th, 21st and 28th day after the removal of nasal packing, a rank-based non-parametric Jonckheere–Terpstra test was used. The paired comparisons within a group between the variables of two successive visits (for example between the 1st and 7th day) were performed using the Marginal

Homogeneity test. p Values $<.05$ were considered significant. The analysis was performed by using the Statistical Package for the Social Sciences (SPSS) software version 15.0 (SPSS Inc., Chicago, IL).

Results

Clinical characteristics and sociodemographic data

Sixty-two patients ($n=62$) with diagnosis of AERD were involved to enter the study. Three ($n=3$) refused to participate and twenty-nine ($n=29$) patients not meeting inclusion criteria. Thirty ($n=30$) patients, operated by the same surgical technique were thus recruited and assigned to Group 1 ($n=15$) and Group 2 ($n=15$). In total, 30 adult patients (17 males and 13 females, aged from 26 to 62 years) with diagnosis of CRSwNP associated with aspirin sensitivity were included in this study. There was no statistically significant difference in age and gender, preoperative nasal symptom score, endoscopic score and Lund–Mackay CT score between groups. The baseline characteristics are presented in Table 1.

Influence of different irrigation solutions on nasal symptoms and endoscopic findings

Comparing individual symptom scores, we found significantly lower scores for nasal obstruction in Group 1 during the 21st and 28th day ($p<.001$; $p<.001$, respectively); lower scores for facial pain/pressure in Group 1 during the 21st day ($p<.001$); lower scores for headache in Group 1 during the 1st, 7th, 14th, 21st and 28th day ($p<.039$; $p<.013$; $p<.007$; $p<.035$ and $p<.048$, respectively); lower scores in Group 1 for trouble sleeping during the 7th, 14th and 28th day ($p=.005$; $p=.001$ and $p=.041$, respectively). We found no significant differences between two groups regarding the scores for nasal discharge. These results are presented in Table 2. Comparing the TSS, we found lower TSS in Group 1 during the 7th, 14th, 21st and 28th day ($p=.009$; $p=.003$; $p=.001$ and $p=.001$, respectively) (Figure 2).

When we compared individual endoscopic scores, we found lower score for mucosal edema in Group 1 during the 28th day ($p<.001$); lower score for nasal secretion in Group 1 during the 21st day ($p=.006$) and lower scores for nasal crusting in Group 1 during the 21st and 28th day ($p=.007$ and $p=.002$, respectively). All these results can be found in Table 2. Comparing the TES, we found

significantly lower TES in Group 1 during the 21st and 28th day ($p=.002$ and $p=.001$, respectively) (Figure 3).

Regarding the paired comparisons within a group between the parameters in two successive visits, we found significantly decreased levels from 1st to 28th day for all individual symptom scores, individual endoscopic scores, TSS and TES. We found no differences for nasal secretion and nasal crusting in Group 1 between the visits on the

Table 2. Primary end-point parameters of patients included in this investigation (Jonckheere–Terpstra test).

Parameter	Hypertonic sea water ($N=15$) Nr (%) / Median (IQR)	0.9% NaCl ($N=15$) Nr (%) / Median (IQR)	p Value
Day 1			
NO	5 (1)	5 (1)	.766
ND	6 (1)	6 (1)	.578
PP	5 (1)	5 (1)	.274
HD	5 (1)	5 (1)	.039
TS	5 (1)	5 (1)	.054
ME	4 (1)	4 (0)	.671
NS	4 (0)	4 (0)	1.000
NC	4 (1)	4 (1)	.264
TSS	24 (4)	27 (2)	.116
TES	11 (1)	11 (1)	.349
Day 7			
NO	4 (1)	4 (1)	.427
ND	4 (1)	5 (1)	.104
PP	4 (1)	4 (1)	.075
HD	4 (1)	4 (1)	.013
TS	3 (1)	4 (1)	.005
ME	3 (0)	3 (0)	.757
NS	3 (1)	3 (0)	.060
NC	3 (1)	3 (0)	.139
TSS	18 (3)	23 (2)	.009
TES	8 (1)	9 (1)	.091
Day 14			
NO	3 (1)	4 (1)	.063
ND	3 (1)	4 (1)	.063
PP	3 (0)	3 (1)	.224
HD	3 (1)	4 (1)	.007
TS	3 (1)	4 (1)	.001
ME	2 (1)	3 (1)	.720
NS	2 (0)	2 (0)	.128
NC	2 (0)	2 (1)	.248
TSS	16 (2)	18 (4)	.003
TES	7 (1)	7 (2)	.201
Day 21			
NO	2 (0)	3 (1)	<.001
ND	2 (1)	3 (2)	.142
PP	2 (0)	3 (1)	<.001
HD	2 (0)	3 (1)	.035
TS	2 (1)	3 (1)	.115
ME	2 (1)	2 (0)	.100
NS	2 (1)	2 (0)	.006
NC	1 (1)	2 (1)	.007
TSS	10 (2)	14 (4)	<.001
TES	5 (2)	6 (2)	.002
Day 28			
NO	1 (1)	2 (1)	<.001
ND	1 (1)	2 (1)	.217
PP	1 (1)	2 (1)	.394
HD	1 (1)	2 (1)	.048
TS	1 (0)	2 (1)	.041
ME	1 (0)	2 (1)	<.001
NS	1 (0)	1 (1)	.112
NC	1 (1)	2 (1)	.002
TSS	6 (2)	9 (4)	.001
TES	3 (1)	6 (2)	.001

NO: nasal obstruction; ND: nasal discharge; PP: facial pain/pressure; HD: headache; TS: trouble sleeping; ME: mucosal edema; NS: nasal secretion; NC: nasal crusting; TSS: total symptom score; TES: total endoscopic score; IQR: interquartile range

Table 1. Baseline characteristics of the patients completing the study.

Characteristics	Hypertonic sea water	0.9% NaCl	p Value
Patients	15	15	
Age, years	43 (22)	47 (14)	.547
Females (%)	7 (47%)	6 (40%)	.717
Males (%)	8 (53%)	9 (60%)	.717
Preoperative total symptom score (TSS)	38 (4)	40 (4)	.382
Preoperative endoscopic score	4 (3)	4 (3)	.418
Preoperative CT score	16 (8)	17 (8)	.513

Age, preoperative endoscopic score, preoperative CT score: median (interquartile range – IQR).

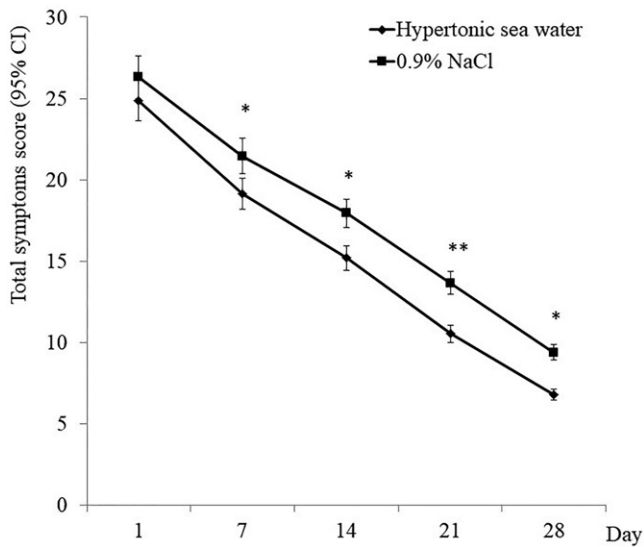


Figure 2. The results showing significantly lower total symptom score (TSS) in Group 1 during the 7th ($p = .009$), 14th ($p = .003$), 21st ($p < .001$) and the 28th day ($p = .001$).

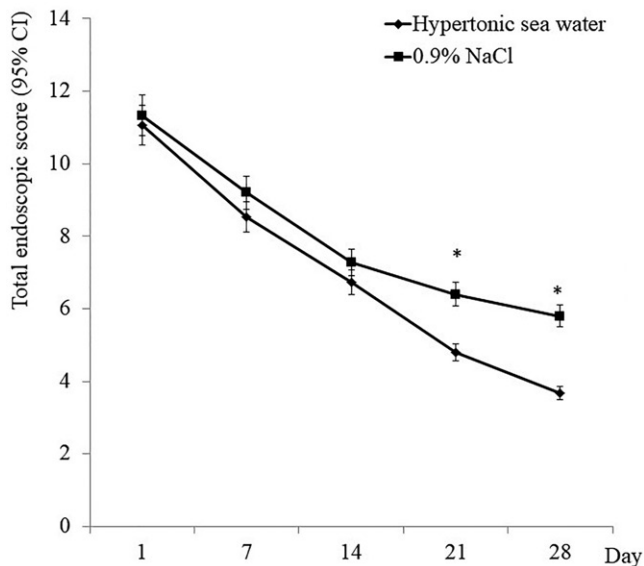


Figure 3. The results showing significantly lower total endoscopic score (TES) in Group 1 during the 21st ($p = .002$) and the 28th day ($p = .001$).

21st and 28th day ($p = .059$ and $p = .083$, respectively). We also found no differences in Group 2 for mucosal edema between the visits on the 21st and 28th day ($p = .564$) and for nasal crusting between the visits on the 14th and 21st day ($p = .317$) and between the visits on the 21st and 28th day ($p = .564$). All these results are presented in Table 3.

Adverse events

Nasal discomforts were detected in two patients after nasal irrigation with hypertonic sea water and in two patients after nasal douching with 0.9% sodium chloride and all those participants complained of mild sensation of prickling in the nasal cavity.

Discussion

The use of different solutions for nasal irrigation is recommended after ESS as inexpensive and effective treatment for improving nasal symptoms and local finding [7,11–18]. Nasal douching can be easily used at home and has relatively small potential for adverse events compared to other conservative treatment modalities. During postoperative care, nasal irrigation can be useful method to minimize crust formation, decrease viscosity of the thick mucus by humidifying the nasal cavity, minimize postoperative infections, promote mucosal regeneration and improve nasal breathing [7,13]. This postoperative care is important especially in patients suffering from AERD where it is necessary to administer nasal corticosteroid sprays or drops immediately after the nasal douching [3–5].

Previous investigations showed that hypertonic solution is more potent than isotonic saline in improving sinonasal symptoms, especially nasal congestion, rhinorrhea, cough, headache and waking up during the night [11,12]. The quality of life in patients with CRS improves sooner with the use of hypertonic sea water solutions [11]. Low et al. [16] showed that douching with lactated Ringer's solution after ESS results in better improvement in sinonasal symptoms, compared with normal saline or hypertonic saline solutions in patients with CRS. However, patients receiving hypertonic saline solutions had less intense polypous changes of the nasal mucosa in the visit at week 6 [16]. The results of this study showed for the first time the beneficial effects of hypertonic sea water in the postoperative care of patients with aspirin-induced CRS. We found significantly lower TSS in patients treated with hypertonic sea water on the 7th, 14th, 21st and 28th days after the removal of the nasal packing in comparison to patients treated with isotonic solution. We found better results regarding the TES in subjects treated with hypertonic sea water on the 21st and 28th days of assessment. According to the presented results, nasal irrigation by hypertonic sea water is superior comparing to isotonic solution in regards to individual symptom scores for nasal obstruction, facial pain/pressure, headache and trouble sleeping. The high salt concentration in hypertonic (2.3% NaCl) sea water is able to reduce nasal mucosal swelling. Lee et al. [17] showed that nasal irrigation using hypertonic sea water improves the mucociliary transport time in subjects with healthy nasal mucosa. The results of a previous investigation suggest that acidic environment in the nasal mucosa, restituted by irrigation with normal saline may cause nasal secretion to be in a "gel", or viscous phase that aggravate mucociliary transport [18]. In contrary, an alkaline milieu in the mucosal layer, restituted by douching with sea water causes the nasal secretion to be in a "sol" phase, improving the mucociliary clearance [18]. Süslü et al. [14] found better mucociliary transport time on the 20th postoperative day after septoplasty in patients treated by hypertonic sea water, whereas Kurtaran et al. [15] showed no such beneficial effect of hypertonic solution. We found no better individual symptom score for nasal discharge in patients irrigated with hypertonic sea water. On the other hand, hypertonic sea

Table 3. Differences with statistical significances (*p* values) in the levels of clinical parameters in the same groups on the visits during the postoperative treatment by different solutions (marginal homogeneity test).

	1st vs. 7th median		7th vs. 14th median		14th vs. 21st median		21st vs. 28th median	
Parameters/day	(IQR) <i>p</i> Value		(IQR) <i>p</i> Value		(IQR) <i>p</i> Value		(IQR) <i>p</i> Value	
(a) Group 1 (Hypertonic sea water)								
Nasal obstruction	1 (0)	<.001	1 (1)	.003	1 (1)	.001	1 (1)	.007
Nasal discharge	1 (0)	<.001	1 (0)	.001	1 (0)	.003	1 (0)	.001
Facial pain/pressure	1 (0)	<.001	1 (1)	.002	1 (1)	<.001	1 (1)	.014
Headache	1 (0)	<.001	1 (1)	.002	1 (1)	.005	1 (1)	.002
Trouble sleeping	1 (0)	<.001	1 (1)	.001	0 (1)	.011	1 (1)	.001
Mucosal edema	1 (1)	.002	1 (1)	.003	1 (1)	.004	1 (1)	.003
Nasal secretion	1 (0)	<.001	1 (1)	.003	1 (1)	.004	0 (1)	.059
Nasal crusting	1 (0)	<.001	1 (1)	.003	1 (1)	.007	0 (0)	.083
Total symptom score	6 (1)	<.001	4 (2)	<.001	5 (2)	<.001	4 (2)	<.001
Total endoscopic score	3 (1)	<.001	2 (1)	<.001	2 (2)	.001	1 (1)	.003
(b) Group 2 (0.9% NaCl)								
Nasal obstruction	1 (0)	<.001	1 (1)	.005	1 (0)	.001	1 (1)	.008
Nasal discharge	1 (0)	<.001	1 (0)	<.001	1 (1)	.002	1 (1)	.001
Facial pain/pressure	1 (0)	<.001	1 (0)	<.001	1 (1)	.001	1 (0)	.001
Headache	1 (0)	<.001	1 (1)	.003	1 (0)	.001	1 (1)	.001
Trouble sleeping	1 (0)	<.001	1 (1)	.002	1 (1)	.003	1 (0)	.001
Mucosal edema	1 (1)	.002	1 (1)	.003	1 (1)	.034	0 (0)	.564
Nasal secretion	1 (1)	.002	1 (1)	.002	1 (1)	.025	1 (1)	.007
Nasal crusting	1 (0)	.001	1 (1)	.004	0 (0)	.317	0 (0)	.564
Total symptom score	5 (0)	<.001	4 (2)	<.001	4 (3)	<.001	4 (2)	<.001
Total endoscopic score	2 (1)	<.001	2 (1)	.001	1 (1)	.007	1 (1)	.029

IQR: interquartile range.

water showed better reduction of nasal secretion amount on endoscopic examination only on 21st day and better reduction of nasal crusting on 14th and 21st days after the start of patient's evaluation. This discrepancy between the symptoms and endoscopic findings could be explained by fact that the production of nasal secretion in aspirin-induced CRS is much higher than in other forms of CRS and that intensive nasal irrigation with hypertonic sea water or isotonic 0.9% NaCl solution cannot eliminate such big amounts of nasal secretion. Endonasal surgery has adverse effects on mucociliary clearance and those adverse effects are much intense in patients after ESS, especially in those with severe aspirin-induced CRS, where it is necessary to remove bigger areas of nasal mucosa with polypous degeneration. Accordingly, the question arises if it is appropriate to measure the mucociliary transport time in patients after ESS. Furthermore, the kind and duration of nasal packing could have additional negative effect on mucosal regeneration after ESS. The ointment component in the cotton wool gauze that we use in our institution allows such nasal packs to slide more easily and prevent adherence to nasal mucosa [19]. Generally, the use of nasal packing for more than 3 days would not be standard and small mucosal lesions as a result of ingrowth of tissue into the packing material are possible [19]. The duration of nasal packing of 4 days in our hospital could be mentioned as a compounding factor that could have the influence on our results.

Regarding the adverse events, nasal discomforts were found in form of sense of prickling in two patients after the nasal irrigation with hypertonic sea water and in two patients after the douching with normal saline. Although previous studies reported that hypertonic solutions cause irritation of the nasal mucosa and nasal burning by stimulation of sensitive nerves and release of substance P and

histamine [12,20], in this study there was no more adverse effects in patients treated with hypertonic sea water comparing to those irrigated with normal saline.

Study limitations

This study has limitation, as it was conducted in a single tertiary care hospital, included relatively small number of patients. In addition, duration of nasal packing was prolonged for more than 3 days. Having peak nasal inspiratory flow (PNIF), rhinomanometry or other objective measurements of nasal patency would increase quality of results, as symptom scores are dependent on a subjective sensation of the participants.

Conclusion

In patients with AERD, nasal irrigation by hypertonic sea water after ESS is superior comparing to isotonic saline in regards to reduction of nasal obstruction, facial pain/pressure, headache and trouble sleeping and it is associated with less nasal mucosal edema, nasal secretion and nasal crusting. Nasal irrigation by 2.3% sea water is superior than 0.9% saline in regards to the reduction of TSS over time during the study and regarding the TES during 21st and 28th day of assessment. Hypertonic sea water should be recommended douching solution in the postoperative care AERD patients.

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Disclosure statement

The authors declare that they have no conflict of interest.

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