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Parotid area sign: A clinical test for the diagnosis of fluid overload in hysteroscopic surgery

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KEYWORDS:
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Parotid area sign;
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Abstract

STUDY OBJECTIVE: To describe the clinical test parotid area sign, which is used to assess fluid absorption during resectoscopic surgery and to compare the test with volumetric fluid balance method with respect to its ability to detect fluid overload.

DESIGN: Historical cohort study (Canadian Task Force classification II-1).

SETTING: Tertiary endoscopy center.

PATIENTS: Eighty-six women who underwent resectoscopic surgery between 1999 and 2004 at our center.

INTERVENTION: The volumetric fluid balance method was used to evaluate glycine absorption (glycine deficit) during the surgery. A flexometallic ruler was placed on the left cheek of the patient between 2 fixed points: the midpoint of the philtrum and a point on the mastoid prominence, and this distance (philtrum-mastoid prominence distance) was measured at the beginning of every 3 minutes during, and at the end of the procedure.

MEASUREMENTS AND MAIN RESULTS: Eighty-six patients were divided into 2 groups: Group A, which included patients with absorption less than 1000 mL as measured by the volumetric method; and Group B, which included patients with absorption of 1000 mL or more. The results of the parotid area sign test in the 2 groups were compared. The 2 groups were comparable with respect to the age, weight, preoperative measured philtrum-mastoid prominence distance, and hospital stay. The median (and average absolute deviation) operating time in group A (15 minutes [and 6.79]; range 8–60 minutes; 95% CI of the median, 15–20 minutes) was significantly lower than the median (and average absolute deviation) operating time in group B (25 minutes [and 8.96]; range 9–60 minutes; 95% CI of the median, 20–25 minutes; $p < .001$). The mean postoperative philtrum-mastoid prominence distance measured in patients of group A (14.23 ± 0.396 cm [range 14–16 cm, 95% CI 14.10–14.36 cm]) was significantly lower than that in group B [14.76 ± 0.622 cm (range 14–17 cm, 95% CI 14.58–15.12 cm]; $p < .001$). By paired *t* test, the change in the philtrum-mastoid prominence distance after surgery as compared with the value before surgery in each patient was found to be insignificant in group A ($p = .86$). However, it was found to be significant in group B ($p < .001$). The increase in the measured philtrum-mastoid prominence distance (i.e., postoperative measurement minus the preoperative measurement) in each patient after surgery was significantly more in group B (mean ± SD, 0.54 ± 0.362 cm [range 0–2 cm, 95% CI 0.43–0.65 cm]) than that in group A (mean ± SD, 0.03 ± 0.091 cm [range

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0–0.4 cm, 95% CI 0.008–0.06 cm]; $p < .001$). The correlation coefficient for the increase in the philtrum-mastoid prominence distance as the glycine deficit increased in the 2 groups considered together was significant ($r = 0.937$, $p < .01$). The partial regression coefficient b value for the effect of duration of surgery while controlling for the effect of fluid deficit was 0.008 ($p < .001$), and the b value for the effect of fluid deficit while controlling for the effect of duration of surgery was 0.437 ($p < .001$). The regression coefficient r value (0.727) for the goodness of the fit of the regression line to the data sets was also significant ($p < .001$). The sensitivity of the test with respect to the volumetric fluid balance is 97.8% (95% CI, 87.28%–99.88%) and specificity is 92.3% (95% CI, 78.03%–97.99%). The negative predictive value is 97.30% (95% CI, 84.19%–99.85%) and positive predictive value is 93.87 (95% CI, 82.13%–98.40%). The conventional positive likelihood ratio for the test is 12.72 (95% CI 4.28–37.77). The conventional negative likelihood ratio is 0.023 (95% CI 0.003–0.16).

CONCLUSION: The parotid area sign is a simple, effective, and easy-to-perform test (in real time continuously) that requires minimal equipment or training. It supplements the volumetric fluid balance method in the detection of fluid overload (1.5% glycine) during resectoscopic surgery. It may also enable us to detect fluid overload when volumetric fluid balance method fails to detect extraneous losses caused by spillage.

The resectoscope is 1 of the most common surgical instruments used today in both gynecology and urology.[1] An important potential problem during resectoscopic surgery is excessive absorption of the fluid used to distend and irrigate the uterine cavity.[2] The rate of fluid intravasation may abruptly and alarmingly increase during endometrial resection.[3] The incidence and severity of symptoms for increasing amounts of absorbed fluid have been best established for glycine solution.[4] Glycine, which is commonly used in resectoscopic surgery, is hypoosmolar, and, hence, its absorption in excess can lead to potentially fatal complications. These include hyponatremia, heart failure, cerebral edema, and even death, similar to the transurethral resection of prostrate (TURP) syndrome.[2] It is therefore necessary to adhere to safety measures, which include the selection of the correct surgical procedure; strict attention to the time factor; and, most importantly, continuous control over the consumption of the medium.[5] Accurate measurement of fluid intake and output remains the mainstay of preventing excess absorption.[6] Such a measurement with current techniques, however, is not without potential problems.[6] None of the described techniques can eliminate completely the complication of fluid overload.[4] Also, many of the techniques studied, such as gravitometry, serial serum sodium measurements, etc, are not available at smaller centers. The method most commonly used is volumetric fluid balance in which the difference between the amount of fluid instilled and volume recovered is calculated. However, its accuracy is hampered by many factors, and there is a need to supplement this method with a simple, clinical, easy-to-perform technique that assesses fluid overload in real time continuously. In this article, we describe our experience with a clinical sign, the “parotid area sign,” which we have successfully used in addition to volumetric fluid balance to detect fluid overload for the last 5 years.

Material and methods

We conducted an historical cohort study of 86 patients (American Society of Anesthesiologists category I and II) undergoing operative hysteroscopic resectoscopic procedures (transcervical resection of the endometrium, hysteroscopic myomectomies, and polypectomies) from 1999 through 2004 in whom we performed the parotid area sign test.

No patient underwent preoperative endometrial preparation. Actual uterine cavity length was less than 8 cm in all patients.

All patients were premedicated with ranitidine 150 mg and metoclopramide 10 mg orally 1 hour before surgery. The patients fasted for at least 8 hours before surgery.

All procedures were done with patients under general anesthesia; induction was carried out with propofol 2 mg/kg, atracurium as muscle relaxant 0.6 mg/kg, and fentanyl 2 μg/kg as the analgesic. Diclofenac suppository 100 mg was inserted in all patients. Intravenous tramadol 50 mg with ondansetron 8 mg was given after surgery in all patients. Classic laryngeal mask application (LMA) size 3/4 was introduced, and patients were ventilated with positive pressure ventilation. Anesthesia was maintained by 50:50 of O_2:N_2O, with isoflurane as the inhalational agent. All patients were placed in the lithotomy position with a head-down tilt of 15 to 20 degrees. The LMA was fixed with a nonelastic string. Monitoring of the patient was done with electrocardiography, pulse oximetry, noninvasive blood pressure measurement, temperature, end-tidal carbon dioxide, fraction of inspired carbon dioxide, agent monitoring, neuromuscular transmission monitoring, spirometry with flow volume and pressure volume loops, inspired and expired tidal and minute volumes, airway pressures, positive end expiratory pressure, lung compliance, and airway resistance measurement.

Distension medium used was glycine 1.5% solution, which was instilled into the uterine cavity with a pressure-controlled peristaltic pump system. We used a 26F continuous-flow resectoscope fitted with a 24F cutting loop. The distending intrauterine pressure was maintained at the minimal levels that provided clear vision, usually 70 mm to 100 mm Hg.[3]

Figure 1 Flexometallic ruler placed on left cheek of patient between a point marked on the mastoid prominence and the midpoint of the philtrum.

Using washable ink, a point was marked on midpoint of the philtrum just below the nasal septum and another on the left mastoid prominence. A flexometallic ruler, which is flexible enough to closely conform to the contours of the patient's face, was then placed on the left cheek between the 2 points at the start of the procedure (Figure 1). This ruler is wrapped around the patient's head and because it has some weight, it stays in place without any additional support. The distance between the 2 points was measured at the start of the procedure, every 3 minutes during, and at the end of, the procedure.

Volumetric fluid balance was also used continuously to measure the amount of glycine instilled into the uterine cavity and the amount recovered and fluid deficit was calculated. Initially, 104 patients were included in the study. However, cervical leak of glycine occurred in 18 patients, and they were excluded from the study. Depending on the calculated amount of fluid absorption, the patients were divided into 2 groups: the patients with fluid absorption less than 1000 mL were included in group A, and those with absorption equal to or more than 1000 mL were placed in group B. This was chosen because 1000 mL of absorption is considered to be a significant milestone during the procedure. There were 39 patients in group A and 47 in group B. The operative procedures performed in the patients of the 2 groups are shown in Table 1.

Data analysis

Age, weight, hospital stay, operating time, input, output, preoperative and postoperative measured philtrum-mastoid prominence distance, and the difference between the preoperative and immediate postoperative measurement of the philtrum-mastoid prominence distance in each patient were recorded in both groups. These measurements were subjected to the Shapiro–Wilk test for assessment of normality and the Levene test for homogeneity of variances to determine whether the assumptions for parametric testing (i.e., normal distributions and homogeneous variances in the groups compared) were met. The operating time in both groups and the increase in the measured philtrum-mastoid prominence distance in group A did not meet either of the 2 assumptions. The increase in the measured philtrum-mastoid prominence distance in the 3 divisions of group B had normal distribution but unequal variance. The rest of the data met both the assumptions. Normal data are presented as mean ± SD with the range and 95% CIs. Non-normal data are presented as median and average absolute deviation with the range and 95% CIs of the median. Continuous data were evaluated by Student's t test and paired t test. Mann–Whitney U test was used to evaluate the difference in the medians of skewed data. Multiple regression analysis was done to measure the effect of time of surgery and fluid deficit on the measured difference in the philtrum-mastoid prominence distance. The partial regression coefficient b value and regression coefficient R value were calculated. Kruskal–Wallis test, the nonparametric alternative to 1-way analysis of variance, was applied where applicable. Nonparametric multiple comparison pairwise comparison was performed by Wilcoxon rank sum test followed by the evaluation of the results by the Bonferroni-corrected alpha values. Because there were 10 comparison groups, the corrected alpha value was 0.05/10 (i.e., 0.005). Therefore $p < .005$ was considered significant for the pairwise comparisons. One-way analysis of variance with the Brown-Forsythe F-test followed by post-hoc Dunnett's T3 test, Tamane's T2 test, and Games-Howell test for multiple comparison pairwise comparison between groups with normal data, but unequal variance was done wherever applicable. Pearson's correlation test was used to compare the fluid absorption with the increase in the measured philtrum-mastoid prominence distance in the patients of both the groups together and in each group separately. A p value below .05 was considered significant for all tests other than the nonparametric multiple comparison pairwise comparisons as described above.

Results

The procedures performed in these 86 patients are listed in Table 1. The 2 groups did not differ significantly in age,

Table 1 Surgeries performed in the 2 groups

Resectoscopic surgeries	Group A	Group B
Transcervical resection of endometrium	21	33
Myomectomy	10	9
Polypectomy	8	5

Table 2 Demographic and operative data

Variable	Group A (n = 39) Mean ± SD (95% CI)	Group B (n = 47) Mean ± SD (95% CI)	p
Age in years	40.92 ± 4.54 (39.47–42.37)	39.59 ± 7.07 (37.53–41.93)	.283
Weight in kg	61.21 ± 8.29 (58.55–63.87)	62.04 ± 5.45 (60.45–63.63)	.576
Preoperative philtrum-mastoid prominence distance in cm	14.21 ± 0.358 (14.09–14.32)	14.23 ± 0.415 (14.11–14.35)	.733
Hospital stay in hours	21.33 ± 3.95 (20.06–22.60)	22.60 ± 1.826 (22.06–23.13)	.06

weight, hospital stay, and preoperative measurement of the philtrum-mastoid prominence distance (Table 2). The mean fluid absorption in group A as measured by volumetric fluid balance was 439.75 ± 203 mL in group A (range 100–900 mL; 95% CI 364.68–504.80 mL) and 1412.77 ± 406.8 mL in group B (range 1000–270 mL; 95% CI 1294.17–1521.37 mL). The mean input in group A was 3293 ± 1534.094 mL (range 1000–6000 mL; 95% CI 2801.89–3785.29 mL) and 5757.45 mL ± 2288 (range 2000–15000 mL; 95% CI 5090.14–6424.76 mL) in group B. The mean output in group A was 2853.85 ± 1459.469 mL (range 650–5700 mL; 95% CI 2386.07–3321.63 mL) and 4255.38 ± 2396.434 mL (range 3000–13800; 95% CI 3556.71–4954.05 mL) in group B.

The median (and average absolute deviation) of the operating time in group A (15 minutes [and 6.79] with range 8–60 minutes and 95% CI of the median, 15–20 minutes) was significantly lower than the median (and average absolute deviation) of the operating time in group B (25 minutes [and 8.96]; range 9–60 minutes and 95% CI of the median, 20–25 minutes; p <.001). The mean postoperative philtrum-mastoid prominence distance measured in patients of group A (14.23 ± 0.396 cm [range 14–16 cm, 95% CI 14.10–14.36 cm]) was significantly lower than that in group B (14.76 ± 0.622 cm [range 14–17 cm, 95% CI 14.58–15.12 cm]; p <.001). By paired *t* test, the change in the philtrum-mastoid prominence distance after surgery as compared with the value before surgery in each patient was found to be insignificant in group A (p = .86). However, it was found to be significant in group B (p <.001). The increase in the measured philtrum-mastoid prominence distance (i.e., postoperative measurement minus the preoperative measurement) in each patient after surgery was significantly more in group B (mean ± SD, 0.54 ± 0.362 cm [range 0–2 cm, 95% CI 0.43–0.65 cm]) than that in group A (mean ± SD, 0.03 ± 0.091 cm [range 0–0.4 cm, 95% CI 0.008–0.06 cm]; p <.001). As the distribution of the measured increase in the philtrum-mastoid prominence distance in group A was not normal, the p value here was calculated by Mann–Whitney test. The median (and average absolute deviation) of the increase in the philtrum-mastoid prominence distance in group A was 0 (and 0.026) with range 0–0.4 and 95% CI of the median 0–0.

As seen in Table 3, in group A, when the glycine deficit was less than 500 mL (group A1), we did not find any increase in the measured philtrum-mastoid prominence distance. From 500 mL to 1000 mL (group A2), however, there was a subjective feel of bogginess and fullness in the parotid area (the mean increase in the distance in group A was 0.05 cm ± 0.126 with median of 0 and an average absolute deviation of 0.053). In group B, when the glycine deficit was less than 1500 mL (group B1), the mean increase in the measured distance was 0.25 cm ± 0.104. The mean increase in the philtrum-mastoid prominence distance was 0.69 cm ± 0.155 when the deficit increased from 1500 mL to less than 2000 mL (group B2). Five patients had a glycine deficit of 2000 mL, and 1 patient had a glycine deficit of 2700 mL. The mean measured increase in the philtrum-mastoid prominence distance was 1.23 cm ± 0.377 in these 6 patients with absorption of 2000 mL and beyond (group B3).

Kruskal–Wallis nonparametric test, performed to find out if there is significant difference in the 5 groups with respect to the increase in the measured philtrum-mastoid prominence distance, was significant at p <.001. Multiple comparison pairwise comparison was then performed between the 5 groups In other words, group A1 was compared with A2, B1, B2, and B3 groups individually, then A2 was compared with B1, B2, and B3 groups individually, then B1 with B2 and B3 groups, and finally B2 with B3 group. Because groups A1 and A2 were non-normal and had unequal variance, nonparametric multiple comparison pair-

Table 3 Mean increase in philtrum-mastoid prominence distance correlated with glycine absorption levels

Fluid absorption (mL)	Mean increase in philtrum-mastoid prominence distance Mean (cm) ± SD (95% CI)	Number of patients
Group A1: ≤499	0 Median and AAD: 0 and 0	20
Group A2: 500–≤999	0.05 ± 0.126 (95% CI 0.006–0.106) Median and AAD: 0 and 0.053	19
Group B1: 1000–≤1499	0.25 ± 0.104 (95% CI 0.207–0.29)	23
Group B2: 1500–≤1999	0.69 ± 0.155 (95% CI 0.62–0.76)	18
Group B3: ≥2000	1.23 ± 0.151 (95% CI 1.11–1.35)	6

AAD = average absolute deviation.

The median and AAD for groups A1 and A2 have been given as the data in the two groups is non-normal.

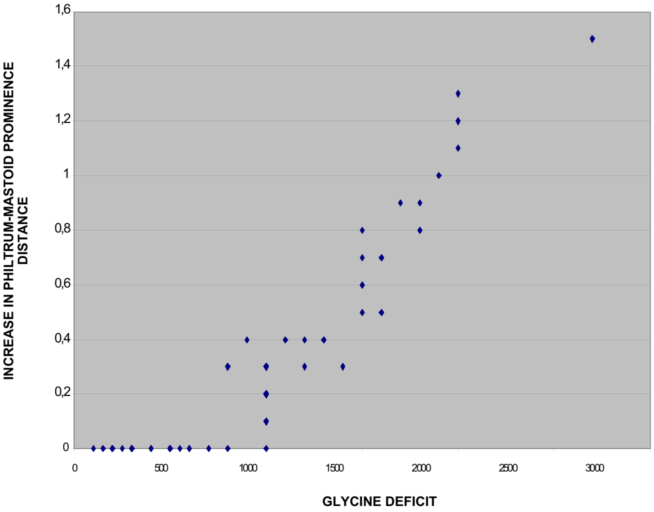

Figure 2 Correlation between glycine deficit and increase in philtrum-mastoid prominence distance.

wise comparison was done with the Wilcoxon rank sum test followed by the evaluation of the results by the Bonferroni-corrected alpha values. In each of these pairwise comparisons, the larger absorption group had a significantly greater increase in the measured distance ($p < .005$) except in the comparison between groups A1 and A2.

Because groups B1, B2, and B3 were normal with heterogeneity of variance, 1-way analysis of variance with the Brown-Forsythe F test was performed. Because the omnibus F-test was significant ($p < .001$), post-hoc multiple pairwise comparison between groups B1, B2, and B3, with Dunnett's T3 test, Tamane's T2 test, and the Games-Howell test, was done. In each of these pairwise comparisons too, the larger absorption group had a significantly greater mean increase in the measured distance ($p < .001$).

An increase in the measured philtrum-mastoid prominence distance during the procedure over the preoperative value was taken as a positive test as the mean increase in the patients with absorption (as measured by the volumetric fluid balance) below 1000 mL was only 0.03 cm ± 0.091. In the total of 47 patients who had a volumetric fluid absorption of 1000 mL or more, only 1 patient had a false-negative result with the parotid area sign, and 46 patients had true-positive results, thus giving a sensitivity of 97.8% (95% CI 87.28 to 99.88%). In the 39 patients who had absorption (as measured by the volumetric fluid balance) below 1000 mL, 3 patients had false-positive results by use of the parotid area sign (values of 0.3, 0.3 and 0.4 cm), and 36 patients had true-negative results, thus giving a specificity of 92.3% (95% CI 78.03%–97.99%). However, in these 3 patients, the fluid deficit as measured by the volumetric fluid balance was 800, 800, and 900, respectively (i.e., very close to 1000 mL). The fact that the parotid area sign was positive when the fluid absorption level as measured by the volumetric balance method was less than 1000 mL could actually mean that some amount of fluid absorbed had not been accounted for by the later method. In these cases, parotid area sign might actually have alerted us to the fact that the absorption was more than 1000 mL. The negative predictive value is 97.30% (95% CI, 84.19%–99.85%), and the positive predictive value of the test is 93.87% (95% CI, 82.13%–98.40%).

The conventional positive likelihood ratio for the test is 12.72 (95% CI, 4.28–37.77). The weighted positive likelihood ratio (weighted by prevalence) is 15.33 (95% CI, 11.48–20.47). The conventional negative likelihood ratio is 0.023 (95% CI, 0.003–0.16). The weighted negative likelihood ratio is 0.028 (95% CI, 0.004–0.19).

In Figure 2, we have considered the patients included in group A and B together to emphasize the proportional increase in the philtrum-mastoid prominence distance as the glycine deficit increases. The correlation coefficient for the increase in the philtrum-mastoid prominence distance as the glycine deficit increased in the 2 groups considered together was significant ($r = 0.937$, $p < .01$). The correlation coefficient (r) for the increase in the measured distance as the glycine deficit increased in the 2 groups considered separately was 0.57 in group A ($p < .01$) and 0.956 in group B ($p < .01$).

Multiple regression analysis was done to evaluate the effects of duration of surgery and the fluid deficit on the measured increase in the philtrum-mastoid prominence distance. The partial regression coefficient b value for the effect of duration of surgery while controlling for the effect of fluid deficit was 0.008 ($p < .001$), and the b value for the effect of fluid deficit while controlling for the effect of duration of surgery was 0.437 ($p < .001$). The regression coefficient R value (0.727) for the goodness of the fit of the regression line to the data sets was also significant ($p < .001$).

No change in hemodynamics or saturation was noticed in any patient in either of the 2 groups. In the 1 patient with a fluid absorption of 2700 mL, the patient had maintained, saturations and was normocapnic at 2000 mL absorption, therefore, the procedure was continued for 4 more minutes because it was nearing completion anyway, and in these few minutes the absorption increased to 2700 mL. At the end of the procedure the patient was given a head-high, 100% oxygen, 40-mg intravenous furosemide injection and was catheterized. All the patients in group B who had an increase in the measured distance and with a glycine deficit of more than 1500 mL were given injection furosemide 20 mg intravenously and were catheterized. Six of these patients reported nausea and vomiting for 6 to 8 hours after surgery.

Discussion

Two of the major complications of fluid intravasation at hysteroscopic surgery are hyponatremic encephalopathy and death.[7] Fluid intravasation remains a risk despite optimal instrumentation and the use of minimal pressures to distend the uterus.[7] Moreover, glycine overload is an acute complication that can occur in a matter of minutes, and diagnosis requires the surgeon to be alert at every point of the procedure and very proactive. But if it is diagnosed early, treatment is effective.

Fluid absorption is slightly more common during transcervical resection of the endometrium (TCRE) than during TURP, with the average being 400 to 700 mL.[8,9] This is primarily because the pressures used in hysteroscopic surgery (70–100 mm of Hg) are higher than those in TURP.

There is a learning curve involved for all surgeons with regard to amount of fluid absorption. The 33 patients in group B (with fluid absorption of 1000 mL or greater) who underwent TCRE underwent operation in the first few years of the study period, and the 21 patients in group A (with absorption less than 1000 mL) underwent TCRE in the later part of the study period. Istre[10] reported absorption in excess of 1.5 L in 9% of 412 patients undergoing transcervical resection of the endometrium. In a large multicentric prospective case series, Jansen et al[11] reported that the incidence can be brought down to less than 1% with experience.

The postoperative signs and symptoms of glycine absorption become more frequent as more irrigating fluid is absorbed.[4] Glycine causes a statistically significant dose-dependent increase in the number and severity of symptoms.[12,13] In 1 retrospective study,[14] patients had an average of more than 1 symptom when they absorbed about 300 mL of glycine. This increased to more than 2 when 1 to 2 L had been absorbed and to more than 3 when 2 to 3 L had been absorbed and to more than 5 for volumes greater than 3 L. Further absorption led to neurologic symptoms. Hahn et al[4] reported that the odds ratio for symptoms to develop was 7 for TURPs, during which 1 to 2 L of glycine had been absorbed. Thus fluid absorption syndrome with glycine has a progressive nature, and it is imperative that absorption above 1000 mL is detected in time so that remedial measures can be taken.

Glycine is a nonessential amino acid with a terminal half-life of anywhere between 40 minutes and several hours.[15] The half-life is dose dependent[16] because of intracellular accumulation of glycine. Although penetration into the central nervous system is restricted, it is clinically important.[17] This is because elimination of glycine occurs primarily in the liver, yielding ammonia. Hyperammonemic encephalopathy may develop when the blood ammonia levels rise above 100 μmol/L.[4] Individual variability may exist, and neurologic symptoms may occur even when blood ammonia levels are normal.[4] Other metabolic products of glycine are also associated with neurologic symptoms like glycolic acid and glyoxylic acid, which accumulate in the cerebrospinal fluid[18,19] and glutamate.

The fluid volume in which the solutes are dissolved adds to the problem of fluid overload. The lower osmolality of the irrigating fluid compared with plasma means that irrigant water enters the cells very quickly after absorption takes place. The excess absorption of water leads to dilutional hyponatremia, hypokalemia, and hypoosmolality, resulting in water intoxication, cerebral edema, and cardiac overload.[20] Glycine intravasation of 1000 mL results in a very significant decrease in serum sodium, which is sufficient to bring a normonatremic patient into the abnormal range.[7]

Circulatory overload causes acute ventricular failure, which in the healthy patient produces tachypnea, wheezing, frothy edema, arterial hypertension, raised venous pressures, bradycardia, and extreme anxiety when awake. Cardiac output falls later with increased end-diastolic ventricular pressure, and the interstitial edema in the lungs progresses to frank pulmonary edema. Normal saline solution, which is used for irrigation with the bipolar resectoscope, can also cause acute volume overload and pulmonary edema.[21]

This potentially disastrous nature of fluid overload makes it imperative that it is detected in time by keeping a strict watch on the volume of fluid that is absorbed. However, currently available techniques for the detection of fluid overload have their own inherent problems.

A good method to quantify fluid absorption in resectoscopic surgeries in which non-electrolyte distending medium is used is the measurement of serum sodium during surgery.[4] The method is best applied repeatedly during surgery. But it is rarely used clinically because of practical problems and invasiveness.[4] Also serum sodium is a poor guide to the degree of extracellular overhydration during the postoperative phase.[22]

Another good method is gravitometry. It is a continuous automated weighing system in which the patient undergoes operation on a bed-scale, and an increase in weight is considered to imply fluid absorption. This technique is quite accurate when one incorporates modern transducers.[23] Varol et al[7] have concluded that this system provides an easy, less time-consuming, and valid method of monitoring fluid deficit. However, it may not be available at all centers where resectoscopic surgery is performed.

Ethanol monitoring method has been well-evaluated worldwide and is considered to be one of the best methods for detecting fluid overload, and 2 comprehensive reviews have also been done.[24,25] But, again, this method may not be available to all surgeons. It also does not detect extravasation of fluid until 15 to 20 minutes later.[26]

Most centers rely on volumetric fluid balance method, i.e., calculation of the difference between the amount of irrigating fluid instilled and the volume recovered. Techniques relying on volume measurements are less accurate than those with weight measurements and can potentially lead to significant underestimation of fluid absorption.[7] There are several pitfalls in calculating fluid deficit, including variations in bag-to-bag content, spillage, blood loss, and urinary excretion.[4] Commercially available containers of fluid may contain 5% to 10% more fluid than is specified.[27] An error of 5% can lead to an additional 1 L absorbed if a total of 20 L is administered.[6]

The need is therefore to develop a simple, effective, easy-to-perform, continuous method for detection of fluid

Figure 3 Edema of parotid area because of fluid absorption.

overload in real time during surgery to supplement the standard methods of detection of fluid overload. In our experience of more than 5 years, we have found that the philtrum-mastoid distance measurement technique fulfills all these requirements. The use of this technique in addition to volumetric fluid balance has alerted us about the fluid status throughout the procedure and enabled us to prevent any major complications. We call this sign "the parotid area sign" because the sign overlies the parotid region. This sign is a reflection of the interstitial edema that develops as a result of the fluid overload. Glycine is absorbed intracellularly and metabolized, leaving excessive free water extracellularly. Excess antidiuretic hormone secretion, which occurs in the stress response to surgery, also reduces renal elimination of the excess water.[28] This results in interstitial edema (Figure 3), which gets reflected as bogginess of the subcutaneous tissue over the parotid region when the absorption is up to 1000 mL. Above 1000 mL, this edema increases to cause a measurable increase in the philtrum-mastoid prominence distance.

Thus this sign is very useful, because the surgeon should be notified about ongoing fluid absorption whenever it exceeds 1 L.[4] Also the calculated glycine deficit often does not reflect true fluid absorption because of extraneous losses (e.g., loss into the bucket, on the drapes, etc.). In other words, due to extraneous fluid losses which can not be quantified, the fluid absorption levels can not be accurately calculated using the volumetric fluid balance method. In such a scenario, the parotid area sign test can be used not only as a supplement to the volumetric fluid balance method but as the main method to determine the glycine deficit levels. In addition, this sign does not require any extra training or additional staff and can be performed by the anesthetist who is monitoring the patient.

The results of our study support our contention that the parotid area sign is a very effective technique and complements the volumetric fluid balance method in the accurate detection of fluid overload. As the fluid absorption increased, the difference in the measured philtrum-mastoid prominence distance also increased proportionately in all the patients considered together ($p < .01$) and in the 2 groups considered separately ($p < .01$). Applying multiple regression analysis, the measured distance was found to be strongly associated with the duration of surgery, as well as the amount of fluid absorption at a p value of less than .001 with a regression coefficient (r value) of 0.727 ($p < .001$).

There was a significant increase in the measured philtrum-mastoid prominence distance when fluid absorption was 1000 mL and above. Generally, we have found that when the fluid absorption is equal to or more than 1000 mL, for every 500-mL increase in absorption, there is an approximately 0.5-cm increase in the philtrum-mastoid prominence distance. The distance starts to increase at approximately 1000 mL. Beyond 1500 mL fluid absorption, the distance is generally above 0.5 cm and above 2 L, the distance increases by more than 1 cm (Table 3). The multiple comparison pairwise comparison tests performed (as seen in the results) support our contention that significant increase in the measured philtrum-mastoid prominence dis-

Table 4 Guidelines for management of fluid absorption followed at our center

Absorbed fluid (as measured by volumetric method) and the measured PM distance	Management
≤499 mL and no change in the measured PM distance	Continue surgery
500–≤999 mL and bogginess but no increase in the PM distance	Continue surgery
<1000 mL by volumetric method but increase in the measured PM distance	Inform surgeon and also recalculate the fluid absorption as measured by the volumetric method
1000–≤1499 mL and an increase in the PM distance by less than 0.5 cm	Inform surgeon. Expedite surgery and terminate.
1500–≤1999 mL and an increase in PM distance above 0.5 cm but less than 1 cm	Inform surgeon. Keep a strict watch on monitoring parameters. Terminate surgery immediately. Catheterize the patient and give 20–40 mg furosemide IV.
≥2000 mL and increase in measured PM distance more than 1 cm	Inform surgeon immediately. Terminate surgery immediately. Catheterize patient and give 100% oxygen, head high position and intravenous furosemide 20–40 mg.

PM distance = philtrum-mastoid prominence distance.

tance occurs only when the fluid absorption is equal to or more than 1000 mL.

The conventional and weighted positive likelihood ratios are both greater than 10, indicating that there is large and almost conclusive evidence that the fluid absorption is more than 1000 mL when there is an increase in the measured philtrum-mastoid prominence distance. Conversely both the conventional and weighted negative likelihood ratios are less than 0.1, indicating that there is large and almost conclusive evidence that the fluid absorption is less than 1000 mL when there is no increase in the measured distance.

An increase in the measured philtrum-mastoid prominence distance is a late change, which indicates fluid absorption of more than 1000 mL and is thus a timely indicator that the resection must be halted to prevent any untoward consequences. In the last 5 years, we have successfully used this technique as a supplement to the volumetric fluid balance method to ensure that there is no serious problem of fluid overload in our patients. The algorithm we use at our center is shown in Table 4.

This technique may also be potentially useful in the detection of fluid overload when normal saline solution is used as a distending medium along with the bipolar resectoscope. However, a study needs to be conducted to detect the approximate amount of absorption at which there is an increase in the measured philtrum-mastoid prominence distance. This amount is potentially greater than 1000 mL because normal saline solution is isoosmolar and distributes equally in all the body spaces.

Conclusion

Resectoscopic surgery is associated with the potentially lethal complication of fluid intravasation and overload. Following a protocol, which entails accurate fluid monitoring and sets a limit to fluid deficit will minimize this risk.[7] Parotid area sign helps in guiding the surgeon continuously about the amount of fluid absorbed during the procedure. It is a late sign that increases the accuracy of volumetric fluid balance method in predicting fluid absorption beyond 1 L and signals the need to terminate the procedure. It is simple, effective, requires minimal training or equipment, and is easy to perform in real time during the surgery. It may be used as the main method to detect glycine deficit levels when the accuracy of the volumetric fluid balance method is hampered by extraneous losses caused by spillage.

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