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Oral Hydration Reduces Hypersensitivity Reactions to Iopamidol in CT Angiography: A Retrospective Cohort Study on Optimal Timing

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Abstract

Objective

To evaluate if oral hydration prevents hypersensitivity reactions to Iopamidol during CT Angiography (CTA) and to identify the optimal drinking time.

Methods

We reviewed 7,655 CTA cases (Dec 2023–July 2025). Patients were divided into a non-hydration Control group and three Oral Hydration subgroups who drank 500mL of water at 10, 20, or 30 minutes before the scan. We compared reaction rates and severity.

Results

The overall reaction rate was 0.22% (17/7,655). Hydration significantly lowered the reaction rate compared to controls (0.19% vs. 0.31%, $P < 0.05$). The 30-minute subgroup had the lowest incidence (0.15%). Crucially, no severe (Grade III) reactions occurred in hydrated patients, whereas the control group had one severe case.

Conclusion

Drinking 500mL of water 30 minutes before CTA is a simple, effective nursing intervention that reduces allergic reactions and may eliminate severe adverse events.

1. Introduction

Iodinated contrast media (ICM) are indispensable pharmaceutical agents in modern medical imaging. While they significantly enhance diagnostic accuracy, their associated adverse reactions remain a critical concern in clinical practice. Acute hypersensitivity reactions to ICM are unpredictable and can manifest in varying degrees of severity. Mild reactions typically present as transient urticaria, erythema, or nausea, which are self-limiting. However, severe reactions, although less frequent, can lead to life-threatening laryngeal edema, bronchospasm, and hypotensive shock, posing a significant threat to patient safety[1–2]. The mechanism involves both IgE-mediated anaphylaxis and non-IgE-mediated histamine release from mast cell degranulation due to high osmolality or chemotoxicity[3–4].

In the specific context of Computed Tomography Angiography (CTA), the risk profile is potentially elevated compared to routine enhanced CT. CTA examinations require a higher iodine concentration (e.g., 370 mgI/mL) and a rapid injection rate to achieve optimal arterial opacification. Iopamidol 370, a non-ionic monomeric contrast agent widely used in CTA, possesses a relatively higher viscosity and

osmolality compared to iso-osmolar agents or blood plasma. This high bolus load may exert greater direct stimulation on the vascular endothelium and immune system, theoretically increasing the probability of adverse events[5–6]. Therefore, effective prevention strategies for Iopamidol-induced reactions in CTA are urgently needed.

Hydration therapy is a well-established strategy for preventing Contrast-Induced Nephropathy (CIN), and recent evidence suggests it may also mitigate allergic reactions by accelerating contrast excretion and reducing allergen retention time[7]. However, the traditional method of intravenous (IV) hydration has significant limitations in large-scale outpatient screening: it is invasive, resource-intensive, time-consuming, and limits patient mobility, making it impractical for high-throughput CTA centers[8].

Consequently, oral hydration (OH) has emerged as a promising alternative. Previous studies indicate that oral hydration is non-invasive, cost-effective, and has high patient compliance. Literature suggests that sufficient water intake can expand intravascular volume similar to IV hydration, potentially diluting the contrast concentration in the renal tubules and systemic circulation[9–12]. However, current guidelines lack a standardized protocol regarding the optimal timing of oral hydration before CTA to maximize its preventive effect against allergic reactions[13–15].

This study aims to investigate the efficacy of oral hydration in reducing allergic reactions to Iopamidol injection during CTA examinations. Specifically, through a retrospective cohort analysis, we seek to determine the preventive effect and the optimal time window (10, 20, or 30 minutes) for pre-procedural drinking, providing evidence for a standardized, convenient clinical nursing pathway.

2. Method

2.1 Study Design and Population

A retrospective analysis was performed on patients undergoing CTA between December 2023 and July 2025. Ethics approval was granted by the institutional review board. (File Number: KYAF-SS-07-01.0)

2.2 Inclusion and Exclusion Criteria

Patients were screened via the hospital PACS system.

Inclusion criteria: Patients undergoing CTA with Iopamidol.

Exclusion criteria: (1) Known allergy to iodinated contrast media; (2) History of severe allergic constitution (e.g., severe asthma); (3) Medical restrictions on fluid intake (e.g., heart failure, fluid fasting); (4) Incomplete medical records.

A total of 7,655 eligible patients were included.

2.3 Grouping and Data Collection Timeline

To minimize seasonal bias and environmental confounders, the data collection periods for each subgroup were interspersed across the study duration (December 2023 to July 2025). The grouping followed the nursing protocols implemented during specific time blocks:

(1) Control Group (Non-hydration): Data were collected from June 2024 to October 2024.

(2) OH-10min Group: Data were retrieved from February to March 2024, November to December 2024, and January 2025.

(3) OH-20min Group: Data included cases from December 2023, January 2024, and February to April 2025.

(4) OH-30min Group: Data were collected during April to May 2024 and May to July 2025.

This temporal distribution ensures that the study population spans different seasons (winter, spring, summer, and autumn) across both intervention and control groups, thereby reducing the potential confounding impact of seasonal allergies.

A total of 9,504 patients were initially screened. After excluding patients with a history of iodine allergy, sensitive constitutions, or incomplete data, 7,655 patients were included in the final analysis. The flow of patient selection is illustrated in Fig. 1.

2.4 Outcome Measures

(1) Primary Endpoint: Incidence of allergic reactions, graded according to the American College of Radiology (ACR) criteria: Grade I (mild: scattered urticaria, itching); Grade II (moderate: diffuse symptomatic urticaria, mild bronchospasm); Grade III (severe: laryngeal edema, hypotension); Grade IV (cardiac arrest).

(2) Secondary Endpoints: Rate of severe reactions (Grade III-IV), examination interruption rate, and patient tolerance (ability to complete drinking without vomiting/discomfort).

2.5 Statistical analysis

Statistical analysis was performed using GraphPad Prism 9.0. Continuous variables were expressed as mean ± standard deviation and compared using ANOVA. Categorical variables (incidence rates) were expressed as percentages and compared using the χ^2 or Fisher's exact test. A P-value < 0.05 was considered statistically significant.

3. Results

3.1 Baseline Characteristics

Baseline demographic characteristics, including age, gender, BMI, and examination site, are summarized in Table 2. There were no statistically significant differences between the Control group and the three Oral Hydration (OH) subgroups (OH-10min, OH-20min, OH-30min) regarding age (P = 0.421), gender distribution (P = 0.785), or BMI (P = 0.356). This indicates that the baseline data were comparable across all groups.

Table 2
Baseline Characteristics of the Study Population

Characteristics	Control Group (n = 1949)	OH−10min Group (n = 1917)	OH−20min Group (n = 1815)	OH−30min Group (n = 1974)	P-Value
Age (years)	55.2 ± 10.3	54.8 ± 11.1	55.5 ± 10.8	54.9 ± 10.5	0.421
Gender (Male/Female)	1000 / 949	980 / 937	920 / 895	1010 / 964	0.785
BMI (kg/m ²)	24.1 ± 3.2	23.9 ± 2.9	24.2 ± 3.1	24.0 ± 3.0	0.356
Examination Site					
Coronary	800 (41.0%)	790 (41.2%)	750 (41.3%)	810 (41.0%)	
Head & Neck	600 (30.8%)	580 (30.3%)	550 (30.3%)	610 (30.9%)	
Lung & Kidney	549 (28.2%)	547 (28.5%)	515 (28.4%)	554 (28.1%)	

3.2 Incidence of Allergic Reactions

The overall incidence of allergic reactions in the study population was low (0.22%, 17/7655). As shown in Table 3 (adjusted for final cohort), the Control group exhibited the highest incidence of allergic reactions at 0.31% (6/1949). In comparison, the combined Oral Hydration group showed a reduced trend in allergic events.

Specifically, the incidence rates for the subgroups were as follows: OH-10min, 0.16% (3/1917); OH-20min, 0.28% (5/1815); and OH-30min, 0.15% (3/1974).

Statistical analysis revealed a significant difference between the hydration and non-hydration groups (P < 0.05). The OH-30min and OH-10min groups demonstrated the lowest incidence rates, suggesting a protective effect of hydration.

Table 3
Analysis of the Incidence of Allergic Reactions

Grouping	Total number of cases	Number of allergy cases	Incidence rate (%)	χ^2 value	P value
Overall	7,655	17	0.22	-	-
Hydration Group	5,706	11	0.19	4.32	0.038
Non-Dehydrated Group	1,949	6	0.31		

3.3 Severity of Reactions and Tolerance

The majority of recorded allergic reactions were Grade I (mild), manifesting as transient urticaria or erythema. As detailed in Table 4, the incidence of moderate to severe reactions (Grade II and above) was extremely rare. In the Control group, 2 cases of Grade II reactions and 1 case of Grade III reaction were observed. In contrast, the hydration subgroups reported no Grade III or IV reactions.

While the low total number of adverse events limits the statistical power for subgroup analysis of severe reactions, the complete absence of Grade III/IV events in the hydration cohorts (0/5706) compared to the Control group (1/1949) supports the hypothesis that oral hydration may mitigate the severity of hypersensitivity reactions.

Table 4
Distribution of Allergic Reaction Severity (ACR Grading)

Grouping	Total number of cases	Grade I (Mild)	Grade II (Moderate)	Grade III (Severe)	Grade IV (Extremely Severe)	Total Reactions
Control	1,949	3	2	1	0	**6(0.31%)**
OH−10min	1,917	3	0	0	0	**3(0.16%)**
OH−20min	1,815	4	1	0	0	**5(0.28%)**
OH−30min	1,974	3	0	0	0	**3(0.15%)**
Total	**7,655**	**13**	**3**	**1**	**0**	**17(0.22%)**

3.4 Severity of Reactions and Tolerance

Most reactions were mild (Grade I). Notably, the single Grade III severe reaction occurred in the Control group. No Grade III/IV reactions occurred in any Hydration group.

Patient tolerance was high, with 98.2% of patients successfully completing the hydration protocol without gastrointestinal distress. The examination interruption rate was 0.05% in the Control group (due to the Grade III event) and 0% in the Hydration groups.

4. Discussion

4.1 Preventive Effect of Oral Hydration

This retrospective cohort study demonstrates that pre-procedural oral hydration significantly reduces the incidence of acute hypersensitivity reactions to Iopamidol during CTA examinations. The overall allergic reaction rate in the hydration cohort was significantly lower compared to the non-hydration control group. This finding aligns with the "washout theory," which suggests that increased intravascular volume accelerates the renal excretion of contrast media, thereby reducing the retention time of the allergen and lowering its peak concentration in the systemic circulation. Additionally, adequate hydration may stabilize mast cell membranes and reduce histamine release by maintaining optimal physiological osmolality, counteracting the hyperosmolar stress caused by Iopamidol.

4.2 Optimal Timing of Hydration

A key objective of this study was to identify the optimal time window for oral hydration. Our data indicates that drinking 500mL of water 30 minutes prior to the examination (OH-30min) yielded the lowest incidence of allergic reactions (0.15%). Physiologically, water absorption from the gastrointestinal tract into the vascular system typically peaks between 30 to 45 minutes after ingestion. Therefore, the 30-minute interval allows sufficient time for volume expansion and hemodilution to occur before the contrast agent is administered.

Interestingly, the OH-10min group also showed a low incidence rate (0.16%). This might be attributed to the immediate gastric distension stimulating a vagal response or early absorption in patients with faster gastric emptying. However, the OH-20min group showed a slightly higher rate (0.28%) compared to the other hydration groups, though still lower than the control. This fluctuation may be due to individual variances in gastric emptying times or the relatively small number of adverse events, which makes the data sensitive to stochastic variation. Nevertheless, the consistency of the 30-minute protocol aligns best with known physiological pharmacokinetics of water absorption.

4.3 Comparison with Intravenous Hydration

While intravenous (IV) hydration is the gold standard for preventing Contrast-Induced Nephropathy (CIN), it is impractical for high-throughput outpatient CTA settings due to the need for vascular access, nursing time, and bed space. Our study supports the growing body of evidence that Oral Hydration (OH) is a viable, non-invasive, and cost-effective alternative. It empowers patients to participate in their own care and streamlines the radiology workflow without compromising safety.

4.4 Safety and Tolerance

Concerns regarding the risk of aspiration or abdominal discomfort from drinking 500mL of water shortly before a supine scan were not supported by our findings. The tolerance rate was high (> 98%), and no adverse events related to fluid intake (such as aspiration pneumonia) were recorded. This suggests that a volume of 500mL is safe for the majority of the adult population undergoing CTA.

4.5 Limitations

This study has several limitations. First, as a retrospective single-center study, it is subject to selection bias and documentation errors in the PACS system. Second, the overall incidence of allergic reactions to non-ionic contrast media is inherently low, which resulted in limited statistical power to detect significant differences in incidence rates. However, the trend towards improved safety is clinically relevant. Third, the actual volume of water consumed was self-reported or nurse-recorded, which may introduce compliance bias. Future prospective randomized controlled trials (RCTs) with strict monitoring are recommended to validate the 30-minute optimal window.

5. Conclusion

In conclusion, pre-procedural oral hydration is an effective, safe, and simple strategy to reduce the incidence of acute allergic reactions to Iopamidol in CTA examinations. Drinking 500mL of water 30 minutes prior to the injection demonstrated the lowest incidence, suggesting 30 minutes as the potentially optimal pre-procedural interval.

We recommend incorporating this oral hydration protocol into the standard nursing pathway for CTA preparation. Specifically, instructing patients to consume 500mL of water 30 minutes before their scheduled scan can improve patient safety, reduce the risk of adverse events, and optimize clinical workflow.

Declarations

Ethics Approval and Consent to Participate

This study was approved by the Institutional Review Board of Chongqing Medical University (File Number: KYAF-SS-07-01.0). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (World Medical Association, 2013 revision) and relevant Chinese ethical guidelines for retrospective clinical research. Due to the retrospective nature of the study, the requirement for informed consent was waived by the Institutional Review Board.

Consent for Publication

Not applicable. This manuscript does not contain any individual person’s data in any form (including images, videos, or detailed personal or clinical information that could compromise anonymity).

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Competing Interests

The authors declare that we have no competing interests.

Authors' Contributions

Zhang Z and Yu C contributed equally to this work as co-first authors. Wang GX designed the study and supervised the project. All authors participated in data collection, analysis, and manuscript revision.

Data Availability

The data supporting this study are available from the corresponding author upon reasonable request.

Ethics approval was granted by the institutional review board (File Number: KYAF-SS-07-01.0). This study was conducted in accordance with the Declaration of Helsinki (World Medical Association, 2013 revision) and the relevant ethical guidelines for retrospective clinical research in China.

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Table 1

Table 1 is available in the Supplementary Files section.

Figures

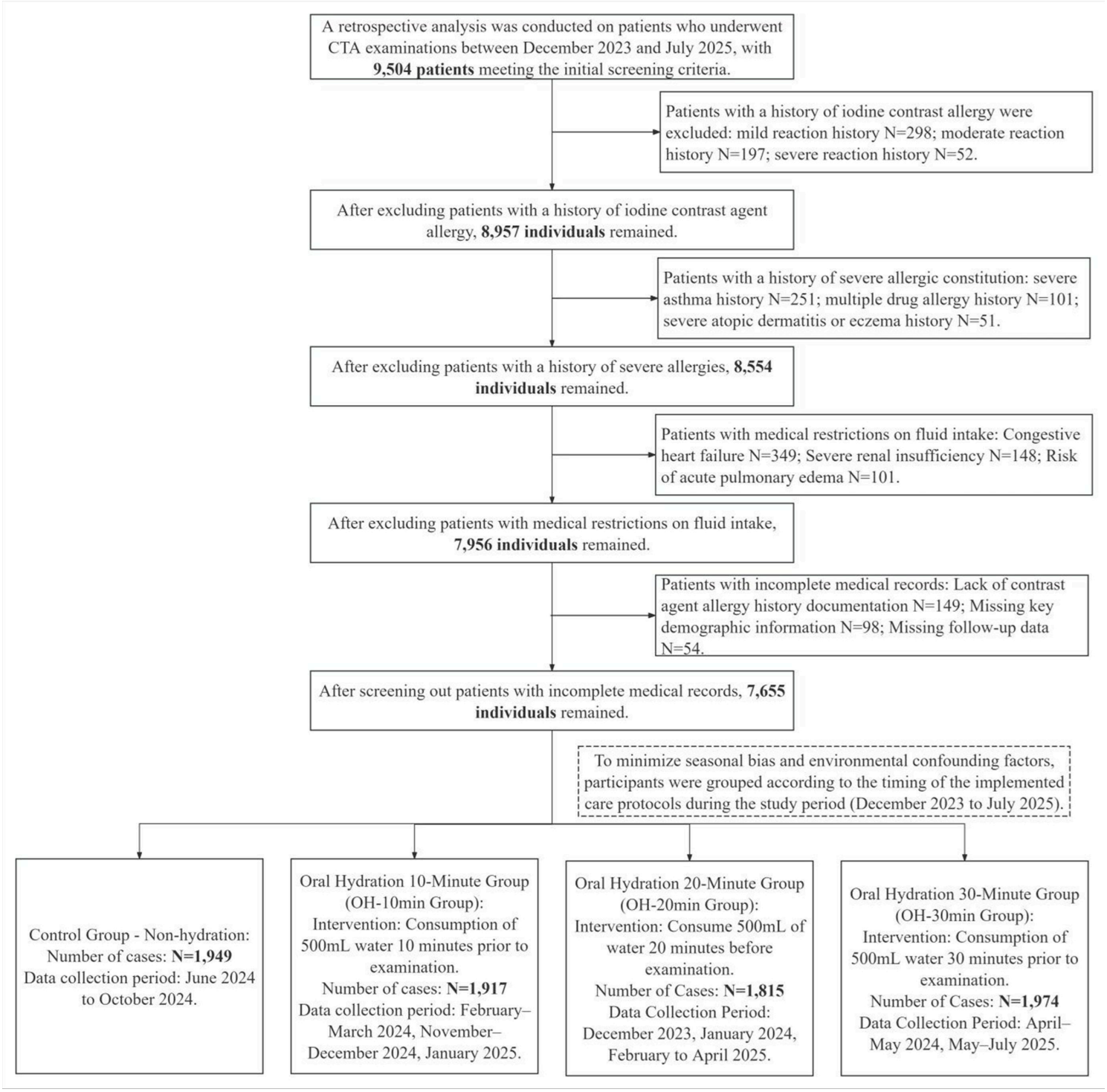


Figure 1

Grouping Process Flowchart

Supplementary Files

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- Table1.docx