

CONTRAST MEDIA AND RADIATION DOSE OPTIMISATION IN GERIATRIC PATIENTS ON POLYPHARMACY UNDERGOING DIAGNOSTIC IMAGING: A CROSS-SECTIONAL STUDY FROM THE KONKAN REGION

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ABSTRACT

Background: Older adults in coastal Maharashtra's Konkan region frequently present for contrast-enhanced and radiation-based imaging while managing multiple chronic conditions and medication regimens. Age-related decline in renal function, altered body composition, and polypharmacy-associated drug interactions may increase the risk of contrast-associated kidney injury, haemodynamic effects of imaging premedication, and cumulative radiation exposure, yet contrast and CT dosing protocols are largely extrapolated from data in younger adults.

Objective: To evaluate the prevalence of polypharmacy among geriatric patients referred for contrast-enhanced and radiation-based imaging, and to propose an age- and renal-function-adjusted framework for contrast media use and radiation dose optimisation in this population.

Methods: A cross-sectional observational study was conducted in tertiary care centres in the Konkan region over an 18-month period. A total of 104 patients aged 65 years and above undergoing contrast-enhanced CT, contrast-enhanced MRI, CT angiography, or fluoroscopic and interventional procedures were enrolled. Medication history, comorbidities, renal function (estimated glomerular filtration rate, eGFR), contrast agent and volume, and radiation dose indices were recorded. Patients were stratified by age band (65–74, 75–84, ≥85 years) and by number of concurrent medications.

Results: Polypharmacy (≥5 concurrent medications) was present in 84 of 104 patients (80.8%), rising from 64.6% in the youngest band to 100% in patients aged 85 years and above. Mean eGFR declined progressively with age (68.4, 54.2, and 41.7 mL/min/1.73 m² respectively). Protocol modification from the standard adult protocol was required in 47 patients (45.2%) overall, most frequently for iodinated contrast-enhanced CT in patients on metformin, ACE inhibitors, NSAIDs, or diuretics, and for iodinated contrast exposure in patients on amiodarone. Imaging-related adverse events were more common in the oldest and most polymedicated group (29.4% versus 6.3% in the youngest band).

Conclusion: Polypharmacy and declining renal function are common among geriatric patients referred for contrast-enhanced and radiation-based imaging in this region, and both materially influence appropriate contrast media selection, contrast volume, and radiation dose. A structured, renal-function- and interaction-aware protocol adjustment framework is proposed and may reduce adverse events without compromising diagnostic image quality.

KEYWORDS: Geriatric radiology; polypharmacy; contrast media; radiation dose optimisation; renal function; Konkan region; drug interactions.

1. INTRODUCTION

The population of older adults in India is expanding rapidly, and coastal regions such as Konkan, characterised by a large proportion of elderly residents due to historical patterns of youth migration for employment, face a disproportionate geriatric care burden. Diagnostic imaging, including contrast-enhanced computed tomography (CT), CT angiography, gadolinium-based magnetic resonance imaging (MRI), and fluoroscopic and interventional procedures, is increasingly requested for this age group as part of oncological staging, cardiovascular risk assessment, and evaluation of acute and chronic illness.

Contrast media dosing schedules and CT acquisition protocols in most departmental practice and manufacturer package inserts are derived from studies in adults without significant multimorbidity. However, ageing is accompanied by well-documented changes in body composition, reduced renal clearance, altered protein binding, and a high prevalence of polypharmacy commonly defined as the concurrent use of five or more medications. These factors can increase susceptibility to contrast-associated acute kidney injury, prolong contrast clearance, and increase the

cumulative radiation burden from repeated imaging in patients with chronic disease.

Polypharmacy is not merely a marker of comorbidity; it independently increases the risk of drug–contrast interactions. Metformin, NSAIDs, diuretics, and ACE inhibitors or angiotensin receptor blockers can increase the risk of contrast-associated nephrotoxicity or lactic acidosis in patients with reduced eGFR, while amiodarone and the iodine load of iodinated contrast together may precipitate thyroid dysfunction. Beta-blockers and calcium channel blockers used for heart-rate control, and nitrates given in CT coronary angiography, can influence haemodynamics and image acquisition in patients already on multiple antihypertensive agents.

Despite this, there is a paucity of region-specific data from India, and particularly from semi-urban and rural coastal belts such as Konkan, describing the burden of polypharmacy in geriatric patients undergoing contrast-enhanced and radiation-based imaging and the extent to which protocol adjustment is currently practised. This study was undertaken to characterise this burden and to propose a practical, evidence-informed framework for contrast and radiation dose individualisation in this population.

2. MATERIALS AND METHODS

2.1 Study design and setting

This was a prospective, cross-sectional, observational study conducted in the departments of Radiology at three tertiary care hospitals serving the Konkan coastal belt of Maharashtra, over an 18-month period.

2.2 Study population

Patients aged 65 years or older referred for any contrast-enhanced CT, CT angiography, contrast-enhanced MRI, or fluoroscopic or interventional procedure were consecutively screened for eligibility. Patients unable to provide informed consent, those with incomplete medication records, and those undergoing emergency procedures were excluded.

2.3 Data collection

For each enrolled patient, the following were recorded:

- Demographic details and indication for the imaging procedure
- Complete medication reconciliation, including prescription, over-the-counter, and herbal/ayurvedic preparations commonly used in the region
- Comorbidities (diabetes mellitus, hypertension, chronic kidney disease, cardiac failure, thyroid disorders)
- Baseline renal function (serum creatinine, estimated glomerular filtration rate via the CKD-EPI equation)
- Contrast agent, volume and injection protocol, radiation dose indices (CTDIvol, DLP, or dose–area product as applicable), any departure from the standard adult protocol, and documented rationale for modification

2.4 Protocol adjustment framework applied

A pre-specified adjustment framework was applied by the reporting radiologist, incorporating age band, eGFR category, number of concurrent medications, and known interacting drug classes. Adjustments were principally applied to iodinated contrast media (reduced volume, iso- or low-osmolar agent selection, and peri-procedural hydration in reduced eGFR), to gadolinium-based contrast (macrocytic agents only, with avoidance of repeat dosing at low eGFR), to metformin and other nephrotoxic drugs (withholding in line with eGFR thresholds), and to CT acquisition parameters (size-adapted, reduced tube current and tube potential with iterative reconstruction).

2.5 Outcome measures

Primary outcomes were the prevalence of polypharmacy by age band, the proportion of patients requiring protocol modification, and the frequency of imaging- or contrast-related adverse events (defined as any new symptom, laboratory abnormality such as a rise in serum creatinine, hypersensitivity reaction, extravasation, or image quality compromise attributable to the procedure within 72 hours).

2.6 Statistical analysis

Continuous variables are expressed as mean $\pm$ standard deviation and compared using one-way ANOVA across age bands. Categorical variables are expressed as frequencies and percentages and compared using the chi-square test. A p-value <0.05 was considered statistically significant. Analyses were performed using standard statistical software.

3. RESULTS

A total of 104 patients (58 men, 46 women; mean age 76.3 ± 7.1 years) were enrolled: 48 in the 65–74-year band, 39 in the 75–84-year band, and 17 aged 85 years or older. The most common indications were contrast-enhanced CT for oncological staging (34.6%), CT angiography including coronary CT angiography (26.9%), contrast-enhanced MRI (19.2%), fluoroscopic and interventional procedures (12.5%), and CT urography or other contrast studies of the renal tract (6.7%).

Table 1 summarises key parameters across the three age bands.

Parameter	Age 65–74 y (n=48)	Age 75–84 y (n=39)	Age ≥85 y (n=17)
Mean no. of concurrent medications	5.9 ± 1.8	8.1 ± 2.3	10.4 ± 2.9
Prevalence of polypharmacy (≥5 drugs), n (%)	31 (64.6)	36 (92.3)	17 (100)
Mean eGFR (mL/min/1.73 m ²)	68.4 ± 12.1	54.2 ± 14.6	41.7 ± 13.8
Contrast-procedure-related	3 (6.3)	7 (17.9)	5 (29.4)
Parameter	Age 65–74 y (n=48)	Age 75–84 y (n=39)	Age ≥85 y (n=17)
adverse events, n (%)			
Protocol modification required, n (%)	9 (18.8)	22 (56.4)	16 (94.1)

Overall, polypharmacy was present in 84 of 104 patients (80.8%), and its prevalence rose significantly with increasing age band ($p<0.001$). Mean eGFR declined progressively from 68.4 mL/min/1.73 m² in the youngest band to 41.7 mL/min/1.73 m² in the oldest band ($p<0.001$). Protocol modification from the standard adult protocol was required in 47 patients overall (45.2%), most frequently in the oldest age band (94.1%) compared with the youngest (18.8%; $p<0.001$).

The most common indications for protocol modification, and the suggested adjustments derived from this cohort, are summarised in Table 2.

Imaging procedure / agent	Standard adult protocol	Suggested adjustment	Key drug interactions noted
Iodinated contrast CT (IV)	Weight-based dose	Reduced volume; iso-/low-osmolar agent; hydration if eGFR reduced	Metformin, NSAIDs, ACE inhibitors/ARBs, diuretics
Gadolinium-enhanced MRI	0.1 mmol/kg	Macrocyclic agent only; avoid repeat dosing at low eGFR	NSAIDs, diuretics, other nephrotoxic drugs
CT acquisition (radiation dose)	Standard adult protocol	Size-adapted mA/kVp; iterative reconstruction	Not drug-driven; age, body habitus, repeat imaging
CT coronary angiography	Standard heart-rate control and nitrate	Cautious beta-blocker and nitrate dosing	Beta-blockers, CCBs, nitrates, PDE-5 inhibitors

Fluoroscopic / interventional	Standard fluoroscopy settings	Dose-minimising (pulsed, collimated); contrast-sparing	Anticoagulants, antiplatelets, metformin, NSAIDs
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Adverse events during or immediately after the procedure occurred in 15 patients overall (14.4%), most commonly mild contrast-associated renal function decline in patients already on ACE inhibitors, diuretics, and NSAIDs, and mild hypotension or bradycardia during heart-rate-lowering premedication for CT angiography in patients on multiple antihypertensive agents. No serious adverse events or procedure-related mortality were recorded. Amiodarone use was identified in 9 patients who received iodinated contrast, all of whom had thyroid function monitoring arranged after the procedure.

4. DISCUSSION

This study demonstrates a high burden of polypharmacy among geriatric patients referred for contrast-enhanced and radiation-based imaging in the Konkan region, with prevalence approaching universal in the oldest old. The parallel decline in renal function with age is consistent with expected physiological ageing and underscores the importance of renal-function-based individualisation of contrast media use, particularly for iodinated agents with predominantly renal excretion.

The findings support existing concerns in the radiology literature that standard adult contrast and CT protocols may not adequately account for the altered pharmacokinetic environment of the polymedicated older patient. The interaction between iodinated contrast and metformin, and the additive nephrotoxic risk with NSAIDs, ACE inhibitors and diuretics, are well recognised and were reflected in this cohort by the frequent need for protocol modification in affected patients. Similarly, the effect of amiodarone on thyroid function after an iodine load remains a practical consideration in follow-up, given the high regional prevalence of cardiac disease and type 2 diabetes mellitus.

The observed association between polypharmacy burden and adverse events, particularly renal function decline after contrast administration in patients on combined ACE inhibitor and diuretic therapy, and hypotension or bradycardia during CT angiography premedication, highlights the value of a structured pre-procedure medication review. Such review could be integrated into existing radiology safety checklists and contrast screening forms without requiring substantial additional resources.

Regional factors specific to Konkan may compound these risks. Migration patterns have left a relatively higher proportion of elderly residents living with limited immediate family supervision of medication adherence, and self-medication with over-the-counter and traditional remedies is common, which may not be reliably captured in routine medication histories. Health system factors, including variable access to specialist geriatric consultation in semi-urban and rural centres, may further limit opportunities for medication reconciliation prior to referral.

This study has several limitations. The sample size, while adequate for descriptive and exploratory analysis, limits the precision of subgroup comparisons, particularly within the oldest age band. Medication histories relied on patient or caregiver report, which may under-capture non-prescription and traditional remedy use. The adjustment framework applied, while pre-specified, was not validated against dosimetric outcome data such as measured radiation dose or standardised diagnostic reference levels, and adverse event definitions were clinical rather than laboratory-confirmed in all cases. Multicentre studies with larger sample sizes, dosimetric validation, and longer-term follow-up are needed to refine and validate structured geriatric contrast and radiation dose protocols.

5. CONCLUSION

Polypharmacy is highly prevalent among geriatric patients undergoing contrast-enhanced and radiation-based imaging in the Konkan region and is strongly associated with declining renal function, increased likelihood of protocol modification, and greater risk of procedure-related adverse events. A structured, age- and renal-function-adjusted framework that accounts for known drug–contrast interactions may improve the safety of radiology practice in this population without compromising diagnostic yield. Wider adoption of routine pre-procedure medication reconciliation is recommended for radiology departments serving similar geriatric-heavy, semi-urban and rural populations.

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