Mitigating Bone Cement Implantation Syndrome in Oncologic Patients Undergoing Cemented Hip and Knee Arthroplasty through Neuraxial or Regional Anesthesia

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Background

Hip and knee arthroplasty in oncologic patients is frequently augmented or supported by the use of polymethyl methacrylate (PMMA) cement or "bone cement". The use of bone cement has been associated with bone cement implantation syndrome (BCIS) which represents a spectrum of clinical symptoms including hypoxia, hypotension, delirium, and cardiac arrest. Intraoperative mortality ranges from 1-5% as a result of BCIS. Proposed mechanisms include systemic embolization of PMMA, histamine release, complement activation, or direct vasodilatory effects of circulating monomers.[6] Optimal anesthetic choices in patients undergoing arthroplasty in oncologic patients has not been explored.

Purpose

- Identify risk factors associated with development of BCIS
- Determine if anesthesia delivery types had mitigating effects on the development of BCIS.

Patients and Methods

We retrospectively reviewed patients ≥ 18 years old who underwent cemented arthroplasty from 2015 - 2020. We defined BCIS as intraoperative (1) drop in systolic blood pressure of 20%, (2) drop in diastolic blood pressure of 10% or (3) hypoxia. or a cardiopulmonary insult within 48 hours of surgery. Demographics, malignancy type, intraoperative factors including cement timing, the development of BCIS, and 30-day outcomes were evaluated.

Results

Overall, 71 patients met inclusion criteria. The two most common primary malignancies were metastatic breast carcinoma (n=17) and primary sarcoma (n=15). 35 patients (49%) developed BCIS, as defined above. There was no difference in age (65 years vs. 60 years; p = 0.43) or Body Mass Index (28 kg/m^2 vs. 30 kg/m^2; p = 0.74), comorbidities, intraoperative factors or post-operative outcomes between those that developed BCIS and those that did not.

There was an association in type of anesthesia administered and development of BCIS (74% vs. 31% vs. 36%, p=0.005) in patients receiving general anesthesia, neuraxial and general, and regional and general anesthesia, respectively. Logistic regression determined 6.3 times higher odds of developing BCIS with use of general anesthesia alone (Confidence Interval (CI): 1.6 – 25.7 p= .008) compared to neuraxial anesthesia. Regional and general anesthesia was not at significantly higher odds of developing BCIS compared to neuraxial and general anesthesia (Odds Ratio: 1.2 CI 0.3 – 4.5 p = .764).

Anesthesia Type	No BCIS	BCIS	Significance
General (G)	7	20	P=0.005
G + Neuraxial	16	5	
G + Regional	18	10	

Association of Anesthesia Type with BCIS

Intraoperative Factors	No BCIS	BCIS	Significance
ASA II	3	3	P=0.881
ASA III	31	29	
ASA IV	2	3	
Total IVF	2383.53 mL	2289.17 mL	P= 0.736
Blood Loss	713.89 mL	728 mL	P= 0.937
Steroid Use	6	11	P= 0.145
Intraoperative HR post cement placement	78 bpm	78 bpm	P= 0.944
Beta Blocker Use	5	8	P= 0.329
Time from cementing to BP Nadir	15.7 minutes	14.7 minutes	P= 0.694
Pressor Required Intraoperatively	26	29	P= 0.284
Intraoperative Death	0	0	N/A

Summary of Intraoperative factors

Conclusion

Regional or neuraxial anesthesia in addition to general anesthesia are associated with decreased incidence of BCIS compared to general anesthesia alone. The addition of regional or neuraxial anesthesia may be protective in reducing the development of BCIS in the orthopaedic oncologic population undergoing hip and knee arthroplasty. Specifically, the use of neuraxial and regional anesthesia support the potential role of a neurologically mediated physiologic response during cementation of implant stems in the development of this process.