Spontaneous Simultaneous Bilateral Basal Ganglia Hemorrhage (SSBBGH): Systematic Review and Data Analysis on Epidemiology, Clinical Feature, Location of Bleeding, Etiology, Therapeutic Intervention and Outcome

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Introduction

Intracerebral hemorrhage (ICH) is defined by the American Stroke Association (ASA) as

Rapidly developing clinical signs of neurological dysfunction attributable to a focal collection of blood within the brain parenchyma or ventricular system that is not caused by trauma.

It is the second most common cause of stroke, accounting for 10–20% of all strokes. It is associated with significant and higher mortality and morbidity compared to ischemic stroke. The most widely used classification of ICH is based on anatomical location into deep subcortical ICH or lobar bleeding. Two etiological classifications have been developed lately but are not widely used. The first one is H-ATOMIC (Hypertension, Amyloid angiopathy, Tumor, Oral
anticoagulants, Malformation, Infrequent, Cryptogenic and Combination) and the second one is SMASH-U classification (Structure vascular lesion, Medication, Amyloid angiopathy, Systemic disease, Hypertension, Undetermined). In most ICH cases, bleeding is solitary and unilateral and few are multiple and bilateral. Although SSBBGH is extremely rare, sporadic cases have been reported across the world. A precious knowledge of SSBBGH can be obtained by extracting the data from these cases and conducting a pooled data analysis. Presently, there is merely a review article by Yang et al, however, that has not provided a comprehensive insight on SSBBGH, since it has not been conducted systematically in accordance with the PRISMA guidelines. Additionally, traumatic etiologies were not excluded, which do not count for ICH as per definition from the ASA. This study aims to conduct an extensive systematic review of non-traumatic SSBBGH to explore more accurate data on epidemiology, demographics, clinical characteristics, etiology and outcome. The main limitations of this study were the rarity of conditions, quality of the studies as all being case reports or case series, wide range of years of publication and insufficient data.

**Methodology**
This review has been carried out in accordance with recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.

**Eligibility Criteria**
Published case reports, case series, case summaries or letters of SSBBGH in patients ≥12 years old. Only articles published in English partly (abstract) or fully (full-text) were reviewed. Articles must have provided sufficient data on epidemiology, demographics, clinical features, etiology, therapeutic intervention and prognosis. Traumatic bilateral basal ganglia bleeding was excluded.

**Search Strategies and Sources**
A comprehensive literature search on PubMed and Scopus was conducted for relevant published studies in English only. The search strategy included the keywords “bilateral basal ganglia hemorrhage” OR “bilateral basal ganglia bleedings”. Each selected full article was further assessed for cross references to find additional reports. Fifteen cases were originally written in Japanese and Chinese, however, we found them summarized and translated in English in other articles. These were included in the analysis.

**Study Selection**
Articles were selected initially based on the relevance to the topic thoroughly reviewing the titles and abstracts by two independent groups of three authors, and then the full texts of eligible articles were retrieved for further assessment and inclusion in this study. Disagreements were resolved by team consensus.

**Data Collection and Management**
Two reviewers independently extracted required data using a predesigned data extraction form (Table 1). The form included country and year of publication, patient demographics, clinical features, location and cause of bleeding as well as therapeutic interventions (conservative vs surgical) and prognosis. If modified Rankin Scale (mRS) was not reported, other available scales or descriptive information on outcomes were transformed into mRS by two authors independently and consensus was reached for any discrepancies. Favorable outcomes were considered as mRS ≤2 and unfavorable outcomes were mRS ≥3-5.

**Statistical Analysis**
A descriptive analysis of the data collected was performed using EXCEL. Continuous variables are presented as mean ± standard deviation (SD), and categorical variables are reported as frequencies and percentages.
| #  | Author, Year and Country | Age/G | Loc. | Clinical Features                                      | Etiology | T  | OC/mRS |
|----|-------------------------|-------|------|--------------------------------------------------------|----------|----|--------|
| 1  | Heck, 2013, France       | 29 M  | BP   | HA, hemiparesis, and dysarthria                         | RLSAA    | C  | Sv/2   |
| 2  | Kabuto, 1995, Japan      | 65 M  | BP   | ALCO and tetraplegia                                   | HTN      | C  | D/6    |
| 3  | Thirunavukkarasu, 2013, | 30 M  | BP   | ALCO, vision loss, and vomiting                         | MI       | C  | Sv/3   |
| 4  | Nadarajah, 2015, India  | 13 F  | BP   | Fever, HA, vomiting, seizure (GTC), and hemiparesis    | DE       | C  | Sv/2   |
| 5  | Asimi, 2007, India      | 65 M  | BP   | Quadruplegia and slurring of speech                     | HTN      | C  | D/6    |
| 6  | Verma, 2006, USA        | 49 M  | BP   | Low-grade fever, ALCO, seizures, and quadriplegia       | ME       | C  | D/6    |
| 7  | Schweyer, 2020, Germany | 51 F  | BP   | ALCO                                                   | OI       | S  | Sv/5   |
| 8  | Finelli, 2015, USA      | 29 M  | BGP  | HA and vomiting                                         | TE       | C  | Sv/2   |
| 9  |                        | 31 M  | BGP  | HA, vomiting, ALCO, and hemiparesis                     | TE       | C  | Sv/4   |
| 10 | Takeuchi, 2009, Japan   | 59 M  | BP   | ALCO                                                   | RLSAA    | S  | Sv/5   |
| 11 | Zhao, 2016, china       | 57 M  | BP   | ALCO                                                   | HTN      | S  | Sv/5   |
| 12 | Daci, 2020, USA         | 60 F  | BP   | HA, cough, fatigue, and ALCO                           | CE-19    | C  | D/6    |
| 13 | Shaheed, 2020, USA      | 62 M  | BP   | ALCO                                                   | HTN      | C  | Sv/1   |
| 14 | Raabe, 1999, Germany    | 46 M  | BGP  | HA, visual aura, and ALCO                              | Migraine | C  | Sv/5   |
| 15 | Erdl-W, 1999, Germany   | 59 F  | BP   | Vertigo, vomiting, ALCO, and quadriparesis             | DKA      | C  | Sv/5   |
| 16 | Boukobza, 2017, France  | 54 F  | BP   | Chest pain, dyspnea, and ALCO                          | HT       | C  | D/6    |
| 17 |                        | 64 M  | BP   | ALCO                                                   | HT       | C  | D/6    |
| 18 | Cho, 2002, south korea  | 40 M  | BP   | ALCO                                                   | HHS      | C  | Sv/5   |
| 19 | Kim, 2015, Korea        | 32 M  | BP   | HA and abdominal pain                                   | MI       | C  | D/6    |
| 20 | Permpalung, 2013, USA   | 56 M  | BP   | ALCO                                                   | MI       | C  | Sv/4   |
| 21 | Westover, 2013, USA     | 58 F  | BP   | HA, aphasia, and bradykinesia                          | RCVS     | C  | Sv/2   |
| 22 | Sarkar, 2003, India     | 40 M  | BP   | Fever, HA, malaise, ALCO, and hemiplegia               | JE       | C  | Sv/1   |
| 23 | Sato, 1986, Japan       | 45 M  | BP   | Hemiplegia, hemihypesthesia, dysphagia, and aphasia     | HT/AC    | C  | Sv/3   |
| 24 | Mauriño, 2001, Argentina| 40 F  | BP   | HA, ALCO, and hemiparesis                              | HTN      | C  | Sv/5   |
| 25 | Yen, 2005, Taiwan       | 64 M  | BP   | Hemiparesis and ALCO                                   | HTN      | C  | D/6    |
| 26 |                        | 49 M  | BP   | Quadruparesis and ALCO                                 | HTN      | C  | D/6    |
| 27 |                        | 55 M  | BP   | Quadruparesis, seizure, and ALCO                       | HTN      | C  | D/6    |
| 28 | Silliman, 2003, USA     | 35 M  | BP   | Anarthria, dysphagia, quadriparesis, and ALCO          | HTN      | C  | D/6    |
| 29 | Hickey, 1983, USA       | 94 F  | BP   | ALCO and seizure                                       | HTN      | C  | D/6    |
| 30 | Nishina, M, 2010, Japan | 74 F  | BP   | ALCO                                                   | HTN      | C  | D/6    |
| 31 | Baldawa, 2015, India    | 60 M  | BP   | HA, ALCO, tetraparesis                                 | HTN      | C  | Sv/5   |

(Continued)
Table 1 (Continued).

| #  | Author, Year and Country | Age/G | Loc. | Clinical Features                          | Etiology | T   | OC/mRS |
|----|--------------------------|-------|------|-------------------------------------------|----------|-----|--------|
| 32 | Takeuchi, 2011, Japan    | 33 M  | Cd   | ALCO                                      | HTN      | S   | Sv/4   |
| 33 |                         | 57 M  | BP   | ALCO                                      | HTN      | S   | Sv/5   |
| 34 |                         | 59 M  | BP   | ALCO                                      | HTN      | S   | Sv/5   |
| 35 | Terzi, 2010, Turkey      | 63 M  | BP   | Hemihypesthesia and speech defects        | HTN      | C   | Sv/1   |
| 36 | Zhang, 2020, China       | 52 F  | BP   | Quadriplegia and ALCO                     | HTN      | S   | Sv/3   |
| 37 | Caparrros-L., 2005, France | 50 M | BGP  | Speak difficulty and ALCO                | MI       | C   | Sv/1   |
| 38 | Haddadi, 2019, Iran      | 54 F  | BP   | ALCO                                      | CE-19     | C   | Sv/1   |
| 39 | Razmjoo, 2010, Iran      | 36 M  | BP   | Vision loss, quadriparetic, and ALCO      | MI       | C   | Sv/5   |
| 40 | Srivastava, 2013, India  | 35 M  | BP   | Blindness and and ALCO                   | MI       | C   | Sv/5   |
| 41 | Hatano, 2017, Japan      | 32 F  | BCd  | Right hemidystonia and mild mental retardation | COL4A1    | C   | Sv/2   |
| 42 | Ari, 2007, Turkey        | 25 M  | BP   | Vomiting, HA, blurred vision, and ALCO    | MI       | C   | Sv/3   |
| 43 | Weisberg, 1989, USA      | 40 M  | BP   | HA, hemiparesis, and hemianesthesia       | Unk      | C   | Sv/1   |
| 44 |                         | 40 M  | BP   | HA, hemiparesis, and hemianesthesia       | Unk      | C   | Sv/1   |
| 45 | Sakai, 1981, Japan *     | 62 F  | BP   | ALCO                                      | HTN      | S   | D/6    |
| 46 | Kamein 1984, Japan *     | 53 F  | BP   | ALCO                                      | HTN      | C   | Sv/-   |
| 47 | Takasugi, 1984, Japan *  | 51 F  | BP   | ALCO                                      | HTN      | C   | Sv/-   |
| 48 | Takasugi, 1984, Japan *  | 58 F  | BP   | ALCO                                      | HTN      | S   | Sv/-   |
| 49 | Shiroyama, 1986, Japan * | 47 M  | BP   | ALCO                                      | MI       | C   | Sv/-   |
| 50 | Yamashita, 1992, Japan * | 89 M  | ALCO | ALCO                                      | HTN      | S   | D/6    |
| 51 | Lin, 1993, China *       | 55 M  | BP   | ALCO                                      | HTN      | C   | D/6    |
| 52 | Lin, 1993, China *       | 64 M  | BP   | ALCO                                      | HTN      | S   | D/6    |
| 53 | Takahashi, 1994, Japan * | 36 M  | BP   | ALCO                                      | HTN      | S   | Sv/-   |
| 54 | Kanehisa, 1994, Japan *  | 46 F  | BP   | ALCO                                      | CSS      | S   | D/6    |
| 55 | Kanehisa, 1994, Japan *  | 80 M  | BP   | ALCO                                      | HTN      | C   | D/6    |
| 56 | Takahashi, 1995, Japan * | 65 F  | BP   | Dysarthria                                | HTN      | C   | Sv/-   |
| 57 | Nishida, 1998, Japan *   | 66 M  | BP   | Hemiplegia                                | HTN      | C   | Sv/-   |
| 58 | Kurino 2000, Japan *     | 72 M  | BP   | ALCO                                      | HTN      | S   | Sv/-   |
| 59 | Lino, 2007, Japan *      | 63 M  | BP   | ALCO                                      | HTN      | C   | D/6    |
| 60 | Wang, 1995, Taiwan *     | 40 M  | BP   | HA and ALCO                               | ToGCV     | C   | Sv/0   |

Note: *Cases were originally written in Japanese or Chinese, however, we found them summarized and translated in English in other articles.[7,9,10]

Abbreviations: G, Gender; M, male; F, Female; Lco., Bleeding Location; T, therapeutic approach; OC, Outcome; mRS, modified Rankin Scale; ALOC, altered level of consciousness (varies from mild somnolence to severe coma); HA, Headache; C, Conservative; S, Surgery; D, Dead; Sv, Survived; BP, Bilateral Putamen; P, putamen; BGP, Bilateral Globus Pallidus; BCd, Bilateral Caudate; Cd, Caudate; RLSSA, Rupture of Lenticulostrate Artery Aneurysms; HTN, Hypertension; MI, Methanol Intoxication; HHS, Hyperglycemic Hyperosmolar syndrome; DKA, Diabetic ketoacidosis; OI, Olanzapine Intoxication; DE, Dengue viral Encephalitis; TE, Toxoplasmosis Encephalitis; CE-19, Covid-19-related Encephalitis; ME, Mucormycosis Encephalitis; JE, Japanese Encephalitis; CSS, Churg Strauss Syndrome; RCVS, Reversible cerebral vasocostriction syndrome; HT, Hemorrhagic Transformation by hypoxic brain injury after cardiac arrest; AC, Anticoagulation; ToGCV, Thrombosis of Great Cerebral Vein; COL4A1, Collagen Type IV Alpha 1 mutation; Unk, Unknown; GTC, Generalized Tonic-Colonic Convulsion; -, no mRS, score reported.
**Result**
A total of 447 articles have been identified. We found 432 articles through PubMed and Scopus and the remaining 15 articles by reviewing article references. There were 19 duplicate articles that were removed. Three hundred articles were excluded due to non-relevance. Twenty-one articles were too old and not retrievable. We ended up with 107 articles that were assessed for eligibility. Of those, 65 articles were excluded for variable reasons: 5 articles because of age below 12 years old, 10 articles due to language barrier (not in English and not translated), 26 articles because of unilateral bleeding, 4 cases of non-simultaneous BBGB, 17 cases of traumatic simultaneous BBGH, and 3 cases with insufficient data. The remaining articles were 42 and included a total of 60 cases. The majority of reports were single case reports (Figure 1).

**Epidemiology**
SSBBGH is more commonly reported in Asia (68.3%) compared to other continents (31.6%). The majority of SSBBGH cases from Asia were from Japan (21/41; 51.2%) and India (6/41; 14.6%). There were only 11 cases (18.3%) reported in

![PRISMA flow chart of this study.](https://doi.org/10.2147/VHRM.S349912)
North America, 7 cases in Europe (11.6%) and 1 case (1%) in South America. To our knowledge, there were no case reports from Australia or Africa. This is most likely due to under-reporting rather than non-existence of the disease, since ICH is common in black as well as in low socio-economic populations. Table 2 summarizes the geographical distribution of reported SSBBGH cases.

**Demographic**
The overall mean age of patients with SSBBGH was 51.86 ±15.69 years. SSBBGH predominantly affects male patients (70%) with M:F ratio of 2.3:1. Male patients tend to be younger (50.8 ± 15.33 years) compared to their female counterparts (54.22 ± 16.67 years).

**Clinical Manifestation**
Altered level of consciousness, focal neurological deficit and headache were the most common clinical manifestations. They were present in 78.33%, 46.66% and 25% of SSBBGH reported cases, respectively. Seizure was an infrequent manifestation that was present only in 6.66% of reported cases. Systemic symptoms including vomiting, abdominal pain and fever were not uncommon (16%) and they were likely due to underlying disease rather than brain bleeding per se.

**Etiology**
Out of 60 reported cases, hypertension was the most common underlying etiology (50%) followed by intoxication and metabolic causes (18.33%). Within the intoxication category, alcohol was the most common offending agent (72.7%).

| Continent/Country          | No. of Cases | Percent (%) |
|----------------------------|--------------|-------------|
| Asia                       | 41           | 68.33       |
| Japan                      | 21           | 35          |
| India                      | 6            | 10          |
| Iran                       | 2            | 3.33        |
| China                      | 4            | 6.66        |
| Taiwan                     | 4            | 6.66        |
| Korea                      | 2            | 3.33        |
| Turkey                     | 2            | 3.33        |
| Europe                     | 7            | 11.6        |
| France                     | 4            | 6.66        |
| Germany                    | 3            | 5           |
| **North America**          | **11**       | **18.33**   |
| USA                        | 11           | 18.33       |
| **South America**          | **2**        | **3.33**    |
| Argentina                  | 1            | 1.66        |
| Australia                  | 0            | 0           |
| Africa                     | 0            | 0           |

Abbreviation: USA, United State of America.
Underlying vascular causes were found only in 16.66% of cases. Infection-related SSBBGH was the least common cause which accounted for only 10% of reported cases. In only 2 patients, there was no defining cause. Co-existence of multiple etiologies is possible. Table 3 summarizes all SSBBGH etiologies in descending order.

Location of Bleeding
Similar to unilateral basal ganglia hemorrhage (UBGH), putaminal SSBBGH was more common (54/60; 90%) than non-putaminal SSBBGH 6/60 (10%).

Therapeutic Approach and Prognosis
Conservative therapy was the main therapeutic approach with only 23.33% of patients undergoing surgical intervention mainly for complication management rather than primary intervention. The overall mortality of SSBBGH is 33.33%.

Discussion
SSBBGH is a rare subtype of ICH that carries similar mortality and morbidity to spontaneous unilateral ICH. Based on our systematic review, SSBBGH is more common in male and Asian ethnicity, similar to unilateral ICH. Decreased level of consciousness was the most common clinical manifestation which is expected given the bleeding is bilateral. The presence of systemic and visual impairment suggest metabolic and intoxication induced rather than brain bleeding per se.

Similar to unilateral deep ICH, hypertensive vasculopathy with formation of microaneurysm (Charcot-Bouchard aneurysm) of lateral lenticulostriate arteries was the main etiology for SSBBGH in patients above 50 years with longstanding hypertension. However, other etiopathogenesis (eg, metabolic, infectious and vascular) (Table 3) was prevalent in the younger patient (<50 years) who presented with normal blood pressure (Figure 2). Ruiz-Sandoval found that the most common cause of unilateral ICH in young populations was vascular malformation (49%).

Table 3 Prevalence of SSBBGH Etiologies

| Aetiology                                      | No. (%)  |
|------------------------------------------------|----------|
| Hypertension                                   | 30 (50%) |
| Metabolic and intoxication                     | 11 (18.33%) |
| Alcohol intoxication                           | 8 (13.33%) |
| Olanzapine intoxication                        | 1 (1.66%) |
| Diabetic ketoacidosis                          | 1 (1.66%) |
| Hyperglycemic hyperosmolar syndrome            | 1 (1.66%) |
| Vascular                                       | 10 (16.66%) |
| Lenticuostriate artery aneurysm                 | 2 (3.33%) |
| Hemorrhagic transformation                      | 3 (5%)   |
| Migraine                                       | 1 (1.66%) |
| Churg strauss syndrome                         | 1 (1.66%) |
| Reversible cerebral vasoconstriction syndrome  | 1 (1.66%) |
| Cerebral vein thrombosis                       | 1 (1.66%) |
| COL4A1 mutation                                | 1 (1.66%) |
| Infection                                      | 6 (10%)  |
| Covid-19-related encephalitis                  | 1 (1.66%) |
| Toxoplasmosis encephalitis                     | 2 (3.33%) |
| Dengue Encephalitis                            | 1 (1.66%) |
| Mucormycosis-caused encephalitis               | 1 (1.66%) |
| Japanese encephalitis                          | 1 (1.66%) |
| Unknown                                        | 2 (3.33%) |

Abbreviation: COL4A1, Collagen Type IV Alpha 1.
Nevertheless, in our search, we could not find any VAM-related SSBBGH cases. Moreover, no primary brain tumor or metastases related SSBBGH were reported in the literature. These two conditions are possible and should always be included in etiological differential diagnoses of SSBBGH.

Traumatic causes of BBGH are beyond the scope of this review; however, if we include traumatic literature, it is the second most common cause after hypertensive vasculopathy. The most common trauma mechanisms were direct head injury, neurosurgical procedures, and lightning strike.7

Forty percent of unilateral ICH occurs in the basal ganglia, particularly the putamen.49 Comparably, SSBBGH occurs predominantly in the putamen (93.3%) which is the most common location for both hypertensive and metabolic SSBBGH. Bleeding predilection to putamen may be due vulnerability of lateral lenticulostriate arteries to chronic hypertension.50 Moreover, some studies suggest that putaminal neurons are very sensitive to metabolic derangement such as acidosis and hypoxia.51

Looking at the literature, there is a comparable mortality rate among patients with either primary UBGH or SSBBGH that ranges from 37% to 46% and this is congruent with this study’s result (33.33%).52,53

**Conclusion**

Health-care providers should be aware of SSBBGH and its underlying etiopathogenesis. The most common cause of SSBBGH is hypertension. However, patients under 50 years with no history of hypertension are likely to have metabolic or intoxication induced SSBBGH which should prompt appropriate etiology-based workup and intervention.
Consent for Publication

Approval from the IRB committee at Imam Abdulrahman Bin Faisal University was not required to publish this article.

Disclosure

The authors report no conflicts of interest in this work.

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