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Clinical and Biological Profile of Patients Treated with Hydroxyurea at the Mother and Child Center of Chantal Biya Foundation

Profil clinique et biologique des enfants drépanocytaires sous hydroxyurée au Centre Mère et Enfant de la Fondation Chantal Biya Yaoundé-Cameroun

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ABSTRACT

Introduction. In Cameroon, sickle cell disease (SCD) remains a concerning condition, with a high proportion of severe forms that require intensification of treatment. Unfortunately, exchange transfusion is not practiced to date and hydroxyurea (HU) remains sparsely prescribed. There are very few studies evaluating the efficacy of HU in our context. We therefore undertook the present study to evaluate efficacy of HU on the clinical and biological profile of SCD children in Yaounde, Cameroon. **Patients and methods.** We did a retrospective cohort study including all sickle cell children aged 2 to 20 years, regularly followed-up at our center, and placed on HU for at least one year before the start of the study. We analyzed clinical data (transfusion needs, frequency of vaso occlusive crisis, serious complications), hemolysis and medullary activity indicators and hemoglobin level before and after initiation of HU with a 12 months follow up. Adverse effects were noted. **Results.** We included 30 patients with homozygous SCD from which 56.7% male. The median age was 96 months (IQR 72-142.5). The main indication of HU was a low basal hemoglobin level (46.7%), followed by severe vaso-occlusive crises leading to at least three hospitalizations per year (40.0%). At 12 months, we noticed a reduction of 90% of admissions and a reduction of duration of hospitalization. Significant increase of weight gain (p< 0.001) and improvement of hemoglobin level. (p<0.001). Few mild adverse effects were reported. **Conclusion.** Hydroxyurea improves clinical and hematological parameters of children and adolescents in MCC/CBF at 12 months.

RÉSUMÉ

Introduction. Au Cameroun, la drépanocytose demeure un problème de santé publique avec une grande proportion de formes sévères nécessitant un traitement intensif. Malheureusement l'échange transfusionnel n'est pas encore pratiqué et l'hydroxyurée (HU) est peu prescrit. Peu d'études ont évalué l'efficacité de ce dernier dans notre contexte. Ceci justifie le présent travail dont le but était d'évaluer l'efficacité clinique et biologique de l'HU chez des enfants drépanocytaires à Yaoundé, Cameroun. **Patients et méthodes** Nous avons réalisé une étude de cohorte rétrospective incluant des drépanocytaires âgés de 2 à 20 ans, sous HU depuis au moins 12 mois consécutifs, suivis dans notre centre. Nous avons analysé leurs données cliniques de sévérité de la maladie, les indicateurs d'hémolyse et d'activité médullaire et le taux d'hémoglobine à l'initiation de l'HU et à 12 mois de suivi. Les effets secondaires étaient notés. **Résultats.** Nous avons inclus 30 patients drépanocytaires homozygotes dont 17(56,7%) étaient des garçons. L'âge médian était de 96 mois (EIQ 72-142,5). Les principales indications de mise sous HU étaient le taux d'hémoglobine bas (46,7%) et les crises vaso occlusives sévères (40%) entrainant au moins 3 hospitalisations annuelles. Après 12 mois, nous avons noté une réduction de 90% des hospitalisations ainsi que la durée d'hospitalisation. Nous avions une prise de poids significative (p< 0.001) ainsi que l'augmentation du taux d'hémoglobine (p< 0.001). Quelques effets secondaires mineurs ont été rapportés. **Conclusion.** L'hydroxyurée améliore les paramètres cliniques et biologiques des enfants et adolescents drépanocytaires au Centre Mère Enfant de la Fondation Chantal Biya.

INTRODUCTION

Sickle cell disease (SCD), also known as hemoglobin S disease, is an inherited autosomal recessive disorder occurring on chromosome 11. It is the most common genetic disease in the world with a clear predominance in the black population [1, 2]. In Cameroon, it constitutes a challenging public health problem two recent studies of neonatal screening showed 15% of carrier(sickle trait), 7,5‰ of sickle cell disease while a real prevalence of the disease in the country is unknown [3,4]. This disease is accompanied by numerous acute and chronic complications that cause high morbidity and mortality [1, 5, 6].

In northern countries, the quality and life expectancy of SCD patients has improved significantly in recent years thanks to neonatal screening, penicillin antibiotic prophylaxis, research and early detection of chronic complications, intensified treatment of severe forms by exchange transfusions and use of hydroxyurea (HU) [7,8,9].

In southern countries and Cameroon in particular, sickle cell disease remains a very concerning condition, with a

high proportion of severe forms that require intensification of treatment [10, 11, 12]. Unfortunately, exchange transfusion is still not practiced to date (high cost, inadequate transfusion safety) and hydroxyurea remains sparsely prescribed (high cost, unavailable medication, reluctance of health care staff and patients, fear of undesirable effects including infertility).

There are very few studies dedicated to evaluating the efficacy of hydroxyurea in the management of severe sickle cell disease in Cameroon. In addition, and for a few years, SCD children followed-up at the Chantal Biya Foundation's Mother and Child Center (Yaounde, Cameroon) are treated with hydroxyurea when there are indications. We therefore undertook the present study to evaluate the effect of hydroxyurea on the clinical and biological profile of SCD children in Yaounde, Cameroon.

MATERIALS AND METHODS

Design and location of the study

We conducted a retrospective cohort study from August 1st, 2014 to July 31, 2015 in the Sickle Cell Child Care Unit of the Mother and Child Center /Chantal Biya Foundation (MCC /CBF). Located in the city of Yaounde, capital of Cameroon, this center has been thoroughly described elsewhere.

Participants

We included all sickle cell children aged 2 to 20 years, regularly followed-up at our center, and placed on HU for at least one year before the start of the study. We excluded children with sickle cell disease who had any other chronic condition (HIV immunodepression, tuberculosis), patients whose clinical records were unusable (incomplete biological data) and those whose treatment with HU was interrupted for at least 4 consecutive weeks during the study period.

Data Collection

We used a standardized questionnaire to collect sociodemographic data, co-morbidity factors, clinical and biological data before and after HU initiation as well as adverse effects. The data was collected at the time of initiation of HU then at 3, 6 and 12 months later, except for hemoglobin electrophoresis that was measured at initiation of HU and 12 months later. Clinical data included transfusion needs, hospitalizations, frequency and severity of vaso-occlusive crises and the occurrence of serious complications (acute chest syndrome, priapism, neurological incidents, etc.). As for the biological data, we noted the basic hemoglobin level (before initiation of HU), the hemolysis indicators (free bilirubin, lactate dehydrogenase (LDH) and medullary activity (reticulocyte, platelet, white blood cell levels)) and hemoglobin electrophoresis. The adverse effects sought were: headache, nausea, vomiting, as well as dermatological abnormalities (pruritus, appearance of the skin and nails).

Statistical analysis

The data was entered and coded using Microsoft Excel v 2010; we analyzed the data using SPSS v. 20.0 (IBM SPSS Inc., Chicago, Illinois, USA). The results are presented as numbers (percentages) for the qualitative variables and means ± standard deviation or medians (interquartile range) for the quantitative variables. Quantitative variables were compared using the Wilcoxon test or the Friedman test; the results were considered statistically significant for a value of $p < 0.05$.

Ethical considerations

Our study was approved by the Institutional Committee of Ethics and Research of the Faculty of Medicine and Biomedical Sciences of the University of Yaounde I. We also obtained a research authorization from the MCC/CBF Directorate. Since the study was retrospective, patient consent could not be obtained. The anonymity of the patients and the confidentiality of the information collected were scrupulously respected.

RESULTS

Thirty patients (56.7% male) were included in this study. The ages ranged from 33 to 240 months with a median of 96 months (IQR 72-142.5). The most represented age group was 5-10 years old (56.7%, Table I). All patients had severe SCD diagnosed between 7 and 84 months of age with a median of 24 months (IQR 12-39).

Table I : Indications for hydrourea initiation

Characteristic		Number (N = 30)	Percentage (%)
Age (years)	< 5	3	10.0
	5-10	17	56.7
	11-15	7	23.3
	16-20	3	10.0
Sex	Males	17	56.7
Indication for HU initiation			
	Prolonged VOC > 1 week/month without hospitalization	6	20.0
	VOC with ≥ 3 hospitalizations/year	12	40.0
	Severe acute chest syndrome	3	10.0
	Neurological incident	5	16.7
	Priapism	2	6.7
	Elevated transfusion needs	10	33.3
	Basal Hb level <7g/dl	14	46.7

HU: hydroxyurea; VOC: vaso-occlusive crisis

Clinical and biological profiles before hydroxyurea initiation

Table I depicts the various indications for HU initiation; one patient could present more than one indication. The main indication was a low basal hemoglobin level (46.7%), followed by severe vaso-occlusive crises causing at least 3 hospitalizations per year (40.0%) and an elevated transfusion need (33.3%; Table I). All patients were taking folic acid and 27 of them (90%) were on preventive antibiotherapy. Levels of hemoglobin, HbF phenotype and serum LDH before initiation of HU are presented in Table II, with respective medians of 6.7 g/l (6.0-7.5), 12.1% (IQR 7.2-18.2), and 2031 IU/l (1408-3560).

Evolution of clinical and biological parameters from HU initiation until 12 months later

Table II presents the evolution of various parameters between HU initiation and 3, 6 and 12 months later. After the first three months, one case (3.3%) of vaso-occlusive crisis causing a hospitalization was recorded; three patients (10%) were hospitalized, all of whom were transfused; one case of acute chest syndrome (3.3%) was reported but no case of priapism or neurologic incident occurred. During the second trimester, 6 patients (20%) were hospitalized and seven patients (23.3%) were transfused; one neurologic incident (3.3%) occurred, but no case of acute chest syndrome or priapism was recorded. During the second semester, 3 patients (10%) were hospitalized with a duration of hospital stay seeming to have decreased in comparison to that at HU initiation (median 7 vs 2 days); no case of acute chest syndrome, priapism or neurologic incident occurred.

Patients' weight gain improved from study baseline to endpoint (median 22 vs 24 kg, p <0.001). Likewise, the HbF percentage increased significantly, as well as the hemoglobin level and the mean corpuscular volume (all p values <0.001; Table II). By contrast but interestingly, the number of reticulocytes, white blood cells, platelets, and serum LDH titers significantly increased over time (p values <0.05; Table II).

Table II: Evolution of clinical and biological parameters

Characteristic	Before or at initiation of HU	At 3 months	At 6 months	At 12 months	p value
Patients with VOC causing hospitalization	14 (46.7)	1 (3.3)	3 (10.0)	0 (0.0)	/
Patients with prolonged VOC without hospitalization	6 (20.0)	1 (3.3)	1 (3.3)	1 (3.3)	/
Patients hospitalized	30 (100.0)	3 (10.0)	6 (20.0)	3 (10.0)	/
Days of hospitalization/month?	7 (6.5-10)	3 (2-/)	6 (3.8-7.8)	2 (2-/)	/
Patients transfused	16 (53.3)	3 (10.0)	7 (23.3)	1 (3.3)	/
Number of blood transfusions[b]	3 (1-3)	1 (1-1)	1 (1-1)	1 (1-1)	
Episodes of ACS	4 (13.3)	1 (3.3)	0 (0.0)	0 (0.0)	
Episodes of priapism	2 (6.7)	0 (0.0)	0 (0.0	0 (0.0)	/
Neurologic incidents	5 (16.7)	0 (0.0)	1 (3.3)	0 (0.0)	/
Weight (kg)	22 (17.5-27.8)	22.5 (18-27)	23 (18-28.8)	24 (18.8-30)	<0.001
Hemoglobin electrophoresis: HbF (%)	12.1 (7.2-18.2)	10.5 (4.5-18.1)	15.2 (13.6-21.6)	20.6 (16.3-25.2)	<0.001[a]
Hemoglobin level (g/dl)	6.7 (6.0-7.5)	7.6 (6.9-8.3)	8.1 (7.4-8.9)	8.3 (7.4-9.4)	<0.001
Reticulocytes (/mm^3)	272090 (179310-367900)	174080 (99190-258787.5)	182400122000-203200)	167880 (101755-202325)	0.019
Mean corpuscular volume (fL)	86.5 (80.0-94.3)	91.0 (85.5-101.5)	92.0 (87.0-103.0)	96.0 (87.5-100.0)	<0.001
White blood cells (/mm^3)	14600 (12375-19875)	11800 (9530-16920)	10700 (6900-14600)	9650 (6050-12500)	<0.001
Platelets (/mm^3)	408000 (340750-525000)	387000 (237500-490500)	333000 (206000-368000)	321000 (246000-419000)	0.003
Serum LDH (IU/l)	2031 (1408-3560)	1018 (897-/)	1283.5 (854.8-2361.5)	1174.5 (946.5-1457.5)	0.019[a]

Data are presented as numbers (percentage) or median (interquartile range) where appropriate; ACS: acute chest syndrome; HU: hydroxyurea; LDH: lactate dehydrogenase; VOC: vaso-occlusive crisis;
[a]Results of the comparison between values at HU initiation and 12 months later, due to the fact that very few patients performed these lab tests at 3 and 6 months; [b]the median number of blood transfusions is given per year before HU initiation, and within the period for other timelines

Adverse effects and adherence to medication

Concerning adverse effects, no patient reported headaches or nausea; one case of transitory vomiting was recorded (3.3%), one case of cutaneous xerosis (3.3%), and one case of nails hyperpigmentation (3.3%). No patient (or patient's parent) had any fear about taking the drug, not even with the knowledge of the risk of infertility.

Further, HU was interrupted among 24 patients (80%), though for less than one month during the 12 months of follow-up. The main reasons for this interruption were: shortage of HU at pharmacies (56.7%), lack of money to buy the drug (20%), and patients' whims (6.7%).

DISCUSSION

This study is among the first in Cameroon to establish the valuable impact of HU in SCD children and adolescents. We recruited 30 patients who had been placed on HU subsequent to one or more clear indications and followed-up until 12 months after drug initiation. Despite drug interruption, mainly due to shortage in pharmacies and lack of money, there was a substantial improvement in clinical and biological parameters: the number of complications (hospitalizations, severe VOC, blood transfusion, ACS, priapism and neurologic incidents) decreased as well as the number of reticulocytes, white blood cells, platelets, and serum LDH titers. On the other hand, there was a significant increase in the weight, HbF percentage, hemoglobin and mean corpuscular volume levels. The drug was well-tolerated and no fear regarding the risk of sterility was reported. Therefore, it is high time HU be introduced in routine clinical care in our country; though it should be prescribed by experienced hands after proof of necessity, and patients/parents should be educated and continuously followed-up to monitor adverse effects.

The median age and the size of our sample are close to those reported in the Mellouli et al study, with median age 9 years (range 2-18 years) and 27 patients [10]. The small size of our study population could be explained by several factors: the unavailability of HU, the elevated cost of the drug, the financial difficulties of the families leading to the non-completion of follow-up biological examinations, hence a high exclusion rate of the files. Indeed, this study was not funded; drug costs and follow-up exams were the sole responsibility of the parents. Efforts could be made to subsidize HU in SCD, or even follow-up examinations as is done in other chronic conditions such as HIV. This would make HU more available and affordable.

We noticed an improvement in clinical parameters: such as a reduction in severe vaso-occlusive crises, a decrease in transfusion needs, a reduction in the occurrence of acute chest syndromes, the number and duration of hospitalizations. These findings are coherent with the literature on the subject [11, 12, 13, 14, 15, and 16]. This can be explained by the mechanism of action of HU: increase in fetal hemoglobin synthesis, induction of nitric oxide synthesis, decrease of red blood cell adhesion to vascular endothelium, modulation of inflammatory phenomena [17, 18, 19, 20]. All this is reflected clinically by a decrease in the severity of the disease [12]. Due to clinical improvement, we observed a reduction in the number of days of hospitalization after one year (median of 7 vs 2 days). These data are similar to those of Gulbis in 2004 and Mellouli in 2013, who reported a considerable reduction in average duration of stay [10, 15].

Similarly, the number of blood transfusions decreased from a median of 3 transfusions/year to a single transfusion after 1 year; in addition, the number of people requiring a transfusion also decreased. These results are close to those of Charache et al. in the United States in 1995 [19] and those of Mellouli [10] et al. in 2013, where the mean transfusion rate decreased from 1.6 transfusions/patient/year to 0.15 transfusion/patient/year. This can be explained by the increase in baseline hemoglobin and hemoglobin F [21, 22, 23].

For biological parameters, a significant increase in fetal hemoglobin, from a median of 12% to 21%, was found in our study, an increase of nearly 9%. This increase is within the range of values found by Mellouli et al. (3 to 30%) [10]. similarly, we recorded a significant increase in hemoglobin levels after one year (median 6.7 vs 8.3 g/dl, $p < 0.001$). At the same time, there was a significant decrease in serum LDH levels (median 2031 vs 1174 IU/l, $p = 0.019$), which marked a considerable reduction in hemolysis [16, 18, 20]. We noticed a reduction in the number of leukocytes (median 14600 vs 9650, $p < 0.001$) and platelets (median 408 000 vs 321 000 / mm3, $p = 0.003$), thus contributing to the reduction in blood viscosity and risk of thrombosis secondary to hypercoagulation [21, 22]. These findings are similar to those of Mellouli, Ferster, and Zimmerman [10, 14, 16, and 19].

With regards to mean corpuscular volume, values increased significantly after one year, from a median of 86.5 to 96 fL. This result is close to that of Ferster et al, who observed an increase of 85.2 to 95.5 fL on average, after ... [16, 18]. The decrease in the number of reticulocytes found in this study is similar to those reported by Mellouli [15]. This decrease could be explained by the fact that HU causes an increase in baseline hemoglobin with a reduction in hemolysis and consequently a less active bone marrow [15, 20, 21, and 22].

These results also testify to the good tolerance of HU in our patients (absence of depression of medullary activity), which could be related to the low doses of the HU used in our series (about 22,4mg/kg). Also further showing the good tolerance of the drug, we have recorded only minimal adverse effects, occurring a few times, in line with previous observations [14, 24]. Clinicians should therefore be encouraged to prescribe this drug if indicated, and patients/parents educated and reassured to give up their fears and apprehensions about the drug.

However, our findings should be interpreted in the context of some limitations. First, we collected our data retrospectively, which implied missing information, precluded from the reporting of the results of the patient/time of follow-up and from investigating other parameters. Second, the absence of a control-arm not taking HU hinders from concluding that what we observed as changes are solely the effects of treatment with HU; it is true nonetheless that this would have posed a serious ethical issue. Third, the changes we observed in this sample of SCD children and adolescents

may be underestimated, when we consider that almost 80% of them interrupted their medication for one reason or the other. Specifically, the study was not funded, which excluded many patients presenting clear indications from initiating HU. Additionally, pharmacists, who were afraid of not being able to selling the drug, did not order it in sufficient quantities, resulting in shortages. Finally, many parents did not have sufficient financial resources to perform all the required laboratory exams, which contributed to rejection of many incomplete patients' files, hence a low sample size.

CONCLUSION

After 12 months, hydroxyurea considerably reduced major SCD complications, significantly improving clinical and biological parameters. Moreover, and interestingly, the drug was well tolerated, with very few and harmless adverse effects. Therefore, it is high time HU be introduced in routine clinical practice for SCD patients in our context. However, the drug should be prescribed by experienced hands after proof of necessity, and patients should be educated and continually monitored.

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Author's contribution

Bibliographic research: ANAY, SSNU, OIH.
Study design: ANAY, SSNU, OIH
Data collection: OIH, ANAY, JMS, EW, SAT
Stat analysis: JRN, OIH, ANAY
Reviewing: POKN, SSNU, ANAY, OIH, JRN, SAT, JMS

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