QUANTITATIVE DETECTION OF REPRODUCTIVE HEALTH RELATED HORMONES IN HUMAN HAIR SAMPLES

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INTRODUCTION

Several hormones, including anti-Mullerian hormone (AMH), progesterone, and cortisol are used to assess fertility, reproductive health and readiness for assisted reproductive procedures, and are usually measured in blood. Hair is a medium that can accumulate biomarkers over several weeks, while serum is an acute matrix that can represent only current levels. Despite this potential utility of measurements of hormones in hair, this medium is not currently employed for human clinical purposes. The objective of this study was to determine if biologically relevant quantities of hormones in human hair samples could be measured.

A total of 152 female participants between the ages of 18-65 years were included in the study. Sample collection was performed in a clinical setting, with blood and hair samples collected from patients. Hair follicles were not required, with a minimum of 100mg of hair cut from the participants. A doctor or a clinical technician measured the antral follicle count (AFC) by ultrasound. Biologically active AMH, progesterone and cortisol were extracted from hair using a proprietary method and were measured in plasma and hair extract by ELISA.

RESULTS

Hormones were detected via ELISA and confirmed on a set of samples via western blots on denatured gel. AMH and cortisol in hair did not significantly associate with measurements in plasma (AMH effect size 0.18, p value 0.0852; cortisol effect size -1.56, p value 0.556) (Table 1). In contrast, the association between progesterone in plasma and hair was significant (p value of 0.013). AMH measured in hair correlated with age more strongly than plasma AMH (p-value < 0.001 (hair), p-value 0.088 (plasma)) (Table 2). AMH levels in hair were also strongly associated with antral follicle count (AFC) (p value of 0.0168) (Table 3, Figure 1).

	effect size (95%CI)	P value
Progesterone	3.47 (95%CI: 1.4; 2.5)	0.01
Cortisol	-1.56 (95%CI: 2.6; -0.6)	0.56
AMH	0.18 (95%CI: 0.1; 1.8)	0.09

Table 1. Relationship of hormone levels in plasma compared to hair extract. Linear regression, adjusting for hair weight, was used to determine associations.

	Average AMH (range)		
Age range	**Hair (pg/ml)[1]**	**Plasma (ng/ml)[2]**	**N**
<25	9.37 (0.32-16.3)	3.68 (1.38-7.54)	20
25-29	5.17 (0.25-16.03)	4.6 (0.94-8.46)	26
30-34	5.89 (0.34-15.28)	3.24 (0.9-8.19)	15
35-39	3.1 (0.17-13.68)	3.34 (0.698-17.68)	28
>39	3.02 (0.12-13.56)	0.92 (0-5.25)	63

Table 2 Relationship of AMH to age. Average AMH level in samples are shown. The association of AMH to age in hair was significant (p value = 1.26e-05), and non-significant in plasma (p value = 0.088)

		effect size (95%CI)	P value
AMH	**Plasma**	1.07 (95%CI: -0.5; 2.6)	0.203
	Hair	3.75 (95%CI: 1.7; 5.8)	0.0168

Table 3. Relationship of AMH with antral follicle count in hair and plasma.

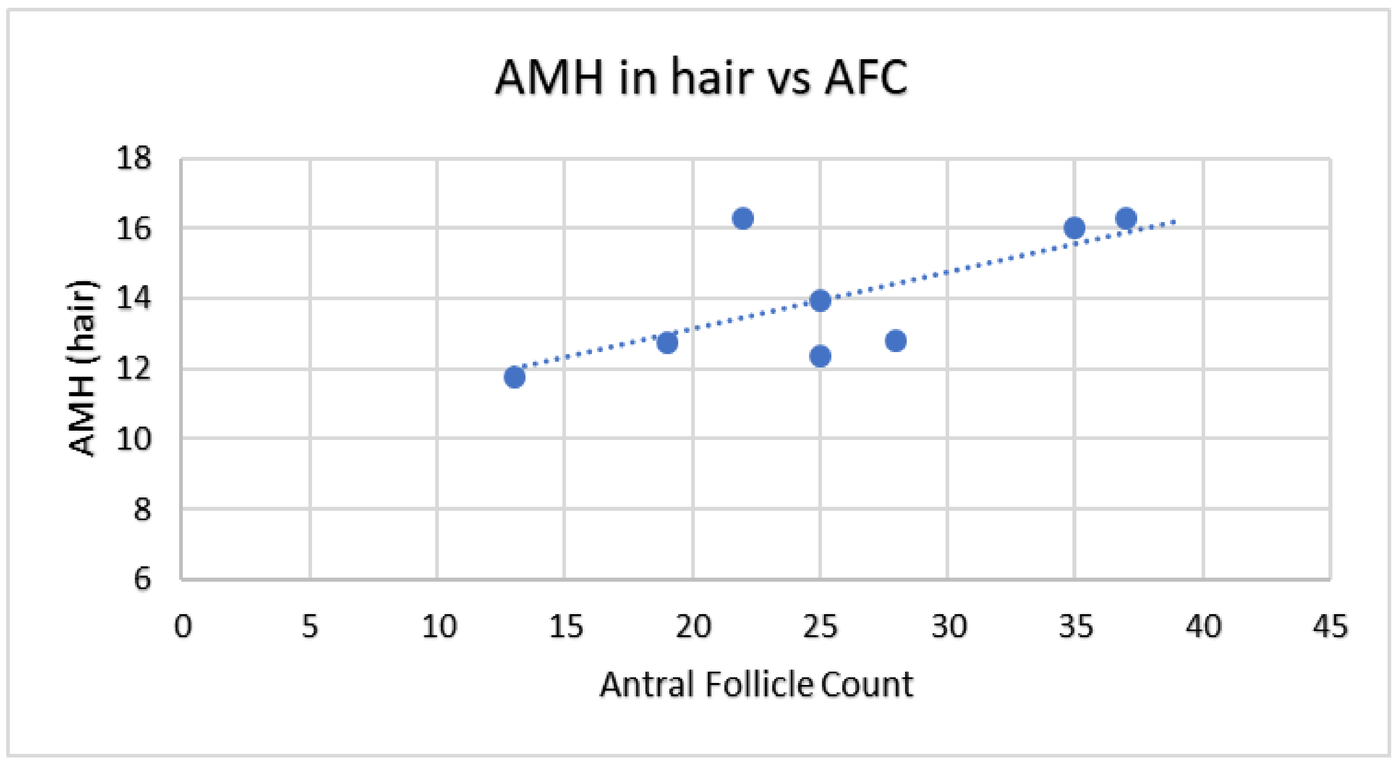

Figure 1. Relationship of AMH level (pg/ml) and antral follicle count.

CONCLUSION

We found several hormones related to reproductive health could be detected in human hair samples, and levels of AMH in hair were positively associated with age and AFC. Measurements of cortisol had the lowest correlation between plasma and hair, consistent with the known rapid changes in plasma concentrations that this hormone can undergo. The stronger association of AMH in hair versus plasma with age and AFC suggests that, though AMH is relatively stable during the monthly cycle, acute measurements of AMH may have variability that may make measurement via hair samples of greater utility than measurements in blood for assessing reproductive health. Hair is a medium that can accumulate biomarkers over several weeks, while serum is an acute matrix that can represent only current levels. Detection of steroid hormones in hair has been used in neuroendocrinological studies in human and animals. However AMH measurements in hair are not currently employed for clinical purposes. Additionally to its apparent better prediction of ovarian reserve as measured by AFC, a non-invasive method of measuring hormones important for assessing reproductive help may allow for an increased clinical adoption of these assays.

CONTACT

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