OBJECTIVE: Oxidation-reduction potential (ORP) is a novel measure of oxidative stress or redox imbalance in biological samples. Static ORP (sORP) provides an integrated measure of the balance between total oxidants and reductants in a biological system, whereas capacity ORP (cORP) equates to the amount of antioxidant reserves. sORP has been shown to correlate well with illness and injury severity that accompanies the state of oxidative stress. cORP correlates with the ability to respond to illness or injury. Our objective was to evaluate whether 1) ORP could be measured in semen and seminal plasma samples and 2) ORP levels correlate with sperm motility.

MATERIALS AND METHODS: Semen samples (n=18) from normal control subjects were divided into two fractions and the seminal plasma was isolated from one fraction (300g, 7min). Sperm count and motility were assessed manually. sORP (µC/106 sperm) and cORP (µC/106 sperm) were measured in both fractions (MiOXSYS, Aytu Biosciences). Values are reported as Mean ± SEM. Spearman correlation and Receiver Operating Characteristic (ROC) analysis were used for statistical analysis.

RESULTS: ORP and cORP levels in semen samples correlated significantly with the levels in seminal plasma. A significant negative correlation existed between sperm motility and cORP in both semen (r=-0.609; P=0.004) and seminal plasma (r=-0.690; P=0.002). Furthermore, a sORP cutoff of 4.73 mV/106 sperm was used for statistical analysis.

CONCLUSIONS: This is the first study to accurately measure sORP and cORP in both semen and seminal plasma samples. Based on high sensitivity as assessed by ROC analysis, the ORP levels can be used to screen infertile men with oxidative stress. These results are being validated in a larger cohort of infertile men.

INTRODUCTION

Male factor infertility is a significant medical condition accounting for up to half of all cases of couple infertility. It affects approximately one in 10 men in the general population and no identifiable cause can be found in over 25% of infertile males. Oxidative stress is well established as a leading contributory factor to male infertility and evidence now suggests that reactive oxygen species (ROS)-mediated damage to sperm is a significant contributing pathogenesis in 30–30% cases of infertility. The quality of semen is considered a key indicator in male fertility, yet a significant proportion of male infertility remains unexplained in part because of the standardized tests available to clinicians and researchers. Currently, the most common method for measuring oxidative stress is by measurement of the levels of ROS by chemiluminescence assay in semen and total antioxidant capacity (TAC) by colorimetric assay in the seminal plasma and subsequently calculating a composite ROS-TAC score. However, the current methods used to measure oxidative stress involve sophisticated instruments, are cumbersome, require large sample volume, and increase the turnaround-time for these tests.

Redox imbalance is caused by a higher production of ROS and reactive nitrogen species or a decrease in endogenous protective antioxidants. Surrogate markers have historically been used to measure redox imbalance in patients (e.g., antioxidants like glutathione, lipid peroxidation, free radical production, protein oxidation, and/or enzyme activity). Relying upon measurements of individual markers often results in an unreliable, variable, and conflicting measurement.

Statistical Analysis

Spearman correlation test was used for statistical analysis to compare quantitative variables. A P value of ≤ 0.05 was considered statistically significant. A Receiver Operating Characteristic curve (ROC) was used to determine the preliminary predictive power of sORP values to identify semen samples with poor motility.

RESULTS

1. Semen sORP levels (3.30 ± 3.835 mV/106 sperm) correlated significantly with the sORP levels in seminal plasma (3.21 ± 3.690 mV/106 sperm) (Figure 1).

2. Semen cORP levels (0.92 ± 0.955 µC/106 sperm) correlated significantly with the cORP levels in seminal plasma (1.09 ± 1.312 µC/106 sperm) (Figure 2).

3. A significant negative correlation existed between sperm motility and sORP in semen (r=-0.609; P=0.004) (Figure 3).

4. A significant negative correlation existed between sperm motility and cORP in seminal plasma (r=-0.690; P=0.002) (Figure 4).

CONCLUSIONS

1. The MiOXSYS test can accurately measure ORP in semen and seminal plasma.

2. Both semen and seminal plasma can be used to measure sORP and cORP levels without sacrificing individual values. sORP values were significantly correlated.

3. Higher sORP measures were associated with lower levels of sperm motility.

4. ORP levels, as assessed by ROC analysis, the ORP levels might be used to screen infertile men with motility abnormalities.