Abstract

The effects of lactated Ringer’s (LR) solution, administered before and during spinal anaesthesia (SA), on some cardiovascular and respiratory parameters were investigated. A total of 15 clinically healthy male Tuj sheep, weighing on average 55±5, at 3-4 years of age were used. The animals were divided into three groups. LR was infused to group I 20 min prior to SA, and to group II immediately after SA equal. In the animals in group III (control group), SA was induced only. LR was infused via the jugular vein, at a dose of 12 ml/kg, over a 20 min period. Eight millilitres of 0.5% bupivacaine was used for the induction of SA. ECG, blood pressure, heart-respiratory rate, and rectal temperature were measured before LR infusion (group I), before anaesthesia (zero min), and at the 5th, 15th, 30th and 60th min after anaesthesia. Temporary arrhythmic waves and extension in P, QRS, T and ST intervals were observed during anaesthesia in all the groups, especially in the controls. The application of LR in Group I was found to be effective for the prevention of bradycardia. Statistically significant (P<0.001) decreases in heart rate were detected in group I at the measured time intervals, while the changes in group I following LR infusion, and in group II at the 5th min of anaesthesia were found to be significant (P<0.01 and P<0.05, respectively). Significant increases (P<0.01) in systolic blood pressure were detected in group I after LR infusion, and in group II at the 5th min of anaesthesia. Furthermore, increases in diastolic blood pressure were detected in group I (P<0.01) at the 30th and 60th min after anaesthesia, and at the 5th min after anaesthesia in group II (P<0.01). There were no changes in body temperature in any group. Decreases in respiratory rate became significant in group I at the 5th and 30th min (P<0.05), and at the 30th min in group II, while there were no significant changes in the controls. The present study showed that the infusion of LR before anaesthesia (group I) was quite effective in the prevention of bradycardia, and in balancing the blood pressure. However, its application in group II was found to be insufficient to exert the same effects.

Key words: sheep, bupivacaine, lactated Ringer’s solution, spinal anaesthesia.
Material and Methods

Animals and groups. The study was carried out on 15 male clinically healthy Tufts sheep, weighing on average 55±5 and 3-4 years of age. The animals were divided into three equal groups. Lactated Ringer’s (LR) solution was infused to group I prior to SA and to group II following SA, whereas in group III (as control) SA was induced only.

Fluid infusion. LR was infused to the animals in group I via the jugular vein at a dose of 12 ml/kg 20 min prior to SA. LR was administered to the animals in group II after bupivacaine injection, by the same route, at the same dose, and at the same period.

Anaesthesia procedure. The animals were restricted in lateral recumbency on an operating table. For the purpose of preventing possible respiratory and circulatory problems, necessary support was provided so as to hold the animals’ neck and thorax in an upward position. The lumbar sacral area was prepared for an aseptic injection. Prior to subarachnoidal (intrathecal) injection, local infiltrative anaesthesia of the subcutaneous tissues and interspinous ligament was achieved. SA was induced by the administration of 8 ml (1.5 ml/kg body weight approximately) of 0.5% bupivacaine (Heavy Marcain, Astra Södertälje, Sweden) through the lumbar sacral space with an 18-gauge, 1.25x90 mm spinal needle. The spinal needle was inserted into the lumbar sacral space and moved slowly forward into the subarachnoidal space. After aspiration of a quantity of cerebrospinal fluid equivalent to the amount of local anaesthetic agent, bupivacaine was injected slowly.

Electrocardiography (ECG) and arterial blood pressure. To obtain ECG results, the animals were positioned in right lateral recumbency, and the hair on the armpit and medial side of the femoral regions was clipped. Electrode clamps smeared with gel were fixed to the clipped region. Using a Logos 8821 electrocardiograph with a speed of 25 mm/s, DI, DII, DIII, aVR, aVL, and aVF derivations were obtained before, and after LR administration, and at the 5th, 15th, 30th and 60th min after anaesthesia for group I; whereas for the other groups the records were measured prior to SA, and at the same time intervals after SA. The heart rate was determined in R-R intervals.

To measure arterial blood pressure, a. femoralis was suitable for the techniques exposed under local infiltrative anaesthesia, and the blood flow was blocked temporarily. A cannula was inserted into the artery and fixed by a silk-thread. The end of the cannula was joined by a rubber tube to a T-pipe connected to a manometer. The manometer was filled with 5% Na-citrate solution given through the T-pipe. The upper end of the manometer was closed, then the arterial clamp was removed and the blood was allowed to pass through. Diastolic and systolic blood pressure was measured at the time intervals set for the study.

Clinical assessments. For all animals, respiratory rate, rectal temperature, and quality of the anaesthesia were evaluated at the same time intervals, which were determined for ECG assessment (Table 1). The respiratory rate was assessed by hand, counting each respiration of air, and the rectal temperature was taken with a digital thermometer. The onset, quality, and margin of expansion of anaesthesia were determined according to the response to electrical stimulation and needle pricks to the skin. When the animal responded to these tests and attempted to stand up, it was considered to have recovered from anaesthesia.

Statistical analysis. All results in each group for the set time intervals were compared with the baseline values, using the Wilcoxon test. Moreover, differences between all the groups at each time interval were also determined by individual comparison using the Mann-Whitney U Test. The SPSS packet programme (version 9.05, 1998) was used for all statistical analyses of each group with the control group.

Results

Anaesthesia observations. Although some slight reactions were observed during local infiltrative anaesthesia of the subcutaneous tissues and interspinous ligament, no reaction was noted during subarachnoidal injection. The desired level of anaesthesia was achieved within 20 to 60 s of the injection, from the local anaesthetic agent. The duration of the efficacy of the anaesthesia was determined to be between 3.5 and 5 h. Clinical assessment produced no evidence of any neurological disorder occurring during or after anaesthesia in any of the animals. Furthermore, no problem related to the intrathecal injection or anaesthesia was observed during a one-week period immediately after the study.

ECG and blood pressure. The electrical impulses in ECG were analysed in DI, DII, DIII, aVR, aVL, and aVF derivations by amplitude and length. The heart rate was determined according to differences in R-R interval in derivation II. The results of ECG indicated that differences in the altitude and length of the P, QRS, T, and ST intervals between groups were statistically significant. After LR administration in group I, the altitude of the electrical direction of the P pulse altered, while an extension in the altitude and the length of the P pulse was observed at the 5th and 60th min (P<0.05). For group II however, the only significant extension in both the altitude and the length of the P pulse was observed at the 5th min (P<0.05). For group I, an increase in the altitude and a decrease in the amplitude of QRS complex were observed (P<0.05) after LR infusion, whereas there was at the 15th and 30th min an increase (P<0.05) in both altitude and amplitude. For group II, on the other hand, an increase in the amplitude and altitude of QRS complex (P<0.05) was determined after the 30th min of anaesthesia.

For group I, a decrease in the altitude and length of the T pulse (P<0.05) was detected after LR infusion; a decrease in its altitude and extension of its length were observed at the 5th min; and an increase in both the length and the altitude of the T pulse (P<0.05) was determined at the 30th min. For group II, an
extension of the length and the altitude of the T pulse (P<0.05) was noted after the 30th min.

While extension of the ST interval was observed at the 5th, 30th and 60th min in controls, the same finding was detected only at the 5th min for group I (P<0.05).

Differences in heart rate in relation to time are given in Table 1. While statistically important decreases (P<0.001) in heart rate were noted throughout anaesthesia in the controls. A clear decrease in heart rate was observed after LR infusion in group I, whereas in group II, a slight decrease (P<0.05) was detected at the 5th min.

A significant increase (P<0.001) in systolic blood pressure was determined following LR infusion in group I; it was then found to have decreased in relation to the baseline values at the 5th and the 15th min, and to have increased (P<0.001) again after the 30th min. For group II, systolic blood pressure was clearly increased (P<0.001) at the 5th min; it then decreased slightly (P<0.01) at the 15th min, returning to its baseline value at the 30th min, and increased again at the 60th min. In the controls, systolic blood pressure decreased markedly at the 5th, 15th and 30th min, but increased significantly (P<0.001) at the 60th min (Table 1).

<table>
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<tr>
<th>Parameter</th>
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<th>20th min after LR</th>
<th>5th min after SA</th>
<th>15th min after SA</th>
<th>30th min after SA</th>
<th>60th min after SA</th>
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<tr>
<td>Respiration</td>
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<td>28.8±3.4</td>
<td>26.8±5.9</td>
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<td>21.2±6.7</td>
<td>18.8±3.9</td>
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<td>II</td>
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<td>29.5±9.2</td>
<td>23.5±8.1</td>
<td>25.5±7.9</td>
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<tr>
<td>Pulse</td>
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<td>88.8±4.5</td>
<td>74.4±7.4***</td>
<td>74.4±7.5***</td>
<td>76.0±4.1***</td>
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<td>I</td>
<td>82.0±5.3</td>
<td>75.6±4.8***</td>
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<td>II</td>
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<td>Systolic blood pressure</td>
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<td>110.4±0.9</td>
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<td>83.2±2.2***</td>
<td>89.6±4.7***</td>
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<tr>
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<tr>
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<td>I</td>
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<td>73.4±8.7</td>
<td>80.8±6.2***</td>
<td>80.4±5.9***</td>
<td>89.0±4.9**</td>
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<td>II</td>
<td>72.2±9.9</td>
<td>72.2±9.9</td>
<td>104.0±5.1***</td>
<td>63.6±9.3</td>
<td>70.2±5.8</td>
<td>92.4±9.5**</td>
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</table>

± SD
*P<0.05, **P<0.01, ***P<0.001
LR: lactated Ringer’s solution
SA: spinal anaesthesia, C: control, I: group I, II: group II.
For group I, while a slight increase in diastolic pressure was observed after fluid infusion, it was found to be decreased at the 5th min, and then increased markedly again (P<0.01) at the 15th, 30th and 60th min. For group II, however, a significant increase (P<0.01) was detected at the 5th min; then, while a slight decline was observed (P<0.05) in the 15th min, it was found increased markedly again (P<0.01) at the 30th and 60th min. In the controls, a reduction in diastolic pressure detected at the 5th min was not significant, however, the decrease was considered to be significant (p<0.05) at the 15th and 30th min.

Respiration. The respiration rate decreased slightly (P<0.05) following LR infusion in group I and at the 5th and 15th min in group II. For group I, the ratio was found to be similar to its baseline value at the other periods studied. For group II, the decline marked at the 30th min had recovered to the normal level at the 60th min. There were no significant differences in the respiration rate of the controls at any of the time periods in the study.

Body temperature. There were no statistically differences in body temperature between the groups with the time.

Discussion

In the present study, rapid, long-lasting, and safe spinal anaesthesia was induced using 0.5% bupivacaine. It has been reported that these properties are due to the rapid absorption of isobaric (0.5%) and hypobaric (0.25%) anaesthetic agents used in spinal anaesthesia (5, 9, 11, 15, 19). In addition, since the nerves in medullar space are not surrounded by dura mater, they are affected rapidly by the anaesthetic agent (4, 11). In this study, the desired quality was achieved within 20-60 s of the injection of bupivacaine, and the duration of effective anaesthesia was found to be 3-5 h.

Lumbosacral epidural and thoracolumbal subarachnoidal segmental anaesthesia techniques are usually preferred for abdominal surgery (4, 9, 11, 16). In our experiment, in order to provide long-lasting and broader area of anaesthesia, a high dose of bupivacaine (8 ml) was used, and the injection was administrated into the lumbosacral space. The occurrence of anaesthesia in a short time following the injection indicates that the high dose of bupivacaine used, plays a critical role here. As the test was performed on an operating table with the animal in lateral recumbency, the loss of motor function of extremities due to the high volume of anaesthetic agent; did not create any disadvantage in relation to our purpose. Additionally, in order to prevent the occurrence of any respiratory problems due to the expansion of bupivacaine in a cranial direction, the animals were kept inclined at approximately 30° during anaesthesia. The cranial expansion line of anaesthesia was restricted in a curve drawn between the umbilicus and T13-L1 space in all cases. The achievement of the desired quality of anaesthesia was determined in all cases, based on electrical stimulation and needle pricks to the affected area.

It has been reported that inflammatory disorders might occur following spinal and epidural anaesthesia (10, 11). In the present study, no findings of neurological disorders were made in any of the animals. Furthermore, some reports have indicated that neurological damage may occur due to a sudden movement of the animal during injection (4, 11, 15). In our study, since the subcutaneous tissues and ligaments were anaesthetised before spinal anaesthesia was performed, no reaction to pain was observed during the forwarding of the spinal needle or piercing of the dura mater.

The occurrence of bradycardia and subsequently hypotension during spinal anaesthesia is considered to be serious problems for clinicians. It has been reported that, if these conditions are not prevented, the animal might die during or after anaesthesia, due to circulatory failure or hypoxia (4, 14). However, the occurrence of this problem depends on anaesthetic agent, amount, and concentration of the drugs, and infusion side (4, 15). In order to prevent this, it has been recommended that the blood pressure should be checked frequently during anaesthesia and that a vasopressor should be administered when necessary (1, 5). However, since this produces a sudden increase in blood pressure, the infusion of crystal and/or colloid fluids intravenously has been recommended as a more practical and safer alternative (1, 4). In the present study, in order to prevent such circulatory problems, the commonly used crystalloid fluid LL was preferred. In this study, differences in the altitude and length of P, QRS, T, and ST complexes in relation to time were detected in group I, group II, and the controls in ECG traces. In the animals administered with the fluid (LR) before spinal anaesthesia (group I), the systolic blood pressure was found to increase for a short time. In spite of this disadvantage, the administration of LR was found to provide the heart with a greater tolerance against anaesthesia, when compared with group II and the controls. Kamenick and Paver–Erzan (6) reported that the infusion of LR before and at the beginning of spinal anaesthesia was successful in keeping cardiac output within its optimal values in humans. Our findings presented in this study are consistent with the data from that report. In our study, differences in heart and, respiratory rates, and body temperature were not statistically significant.

In conclusion, it was determined that the infusion of LR before spinal anaesthesia (group I), prevented bradycardia and subsequent hypotension; and kept cardiac output within normal values, thus it was providing safer anaesthesia. For group II however, its application was found to be insufficient to produce the same desired effects.
References