Robert Jones Bandage Report

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Abstract:
Little or no data has been collected on the performance of the Robert Jones bandage with respect to its use in the event of equine leg injury. The comparisons of effects and interactions of different wrap procedures is an important tool in understanding and improving upon the Robert Jones bandage. Under the direction of Lucas Reid and Dr. Robert Stephens, we designed an experiment to determine the best procedure considering key variables. Due to the comparative nature of the experiment many external variables were eliminated, allowing the analysis to remain focused on the support given by the bandage. Testing consisted of deflection measurements taken from a static creep test of the bandage under light load over a period of fifteen minutes. A factorial analysis determined that a full Robert Jones bandage with a 6 inch overlap between wraps was the most supportive among those tested. Also a centering offset of up to 4 inches above the fracture was determined to be a statistically insignificant factor.

Introduction:

Background:
The Robert Jones Bandage has been used for 40 years to wrap horses’ legs when they are fractured in the field. It is used to immobilize the leg while the horse is being transported to care. In the 1800’s the bandage was first used as a means to wrap up human limbs. It was still being used during WWII to wrap injured soldiers in the field. It gets its name from Robert Jones who used this wrapping method though there is no evidence that he was the first to do so. (James David Brodell. David L Axon. C. McCollister Evarts, 1986) Although medical care for humans has vastly improved since the 40’s this bandage has not. It is no longer used on humans, but it is still the primary wrap used for horses and other animals.

Motivation:
The Robert Jones bandage is same today as it was originally. There is little documentation on the support given by this bandage. Hundreds of horses get injured every year and are wrapped using the Robert Jones bandage before being transported to care. During transport many of these horses’ exacerbate their injuries and have to be euthanized. If the Robert Jones Bandage can be improved many of these horses could recover. All of our data will be used to complement the research of Lucas Reid in the development of a better splinting technique or mechanism.
**Objective:**

We will be examining different wrap styles under static loading conditions to acquire data on the support given by the bandage. Using this data we will make a recommendation for the most effective wrapping procedure.

**Methodology:**

**Experimental Apparatus:**

To collect our data we used a simple setup of a hinged 4x4 post to emulate a fracture. This allows us to consistently test the support given by different wraps by keeping most external factors constant. A schematic of our test apparatus is shown below in (Figure 1).

Each wrap consists of a layer of 14 inch wide cotton padding overlaid by a 3 inch ace bandage. The deflection is measured at the end of the beam; each test starts in the horizontal position, and when the support is removed the height measurement is made from floor using a yard stick. A 2 pound weight is added to intensify the deflection.

(Figure 1) Double Wrap Robert Jones Bandage
Experimental Design:

A number of experiments were set up to determine support given by different wrapping procedures. The different wrapping procedures are based on the commonly taught procedure of the Robert Jones bandage. The different experiments will vary the different independent variables in the commonly taught procedure. The independent variables and their ranges are shown below in (Table 1.) Testing the support of each wrap will be done by measuring deflection, which is the dependent variable.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Range of Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of wraps</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Center Offset</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2 in.</td>
</tr>
<tr>
<td></td>
<td>4 in.</td>
</tr>
<tr>
<td>Overlap</td>
<td>2 in.</td>
</tr>
<tr>
<td></td>
<td>4 in.</td>
</tr>
<tr>
<td></td>
<td>6 in.</td>
</tr>
<tr>
<td>Loading</td>
<td>0 lb.</td>
</tr>
<tr>
<td></td>
<td>2 lb.</td>
</tr>
<tr>
<td>Time</td>
<td>0 min</td>
</tr>
<tr>
<td></td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>6 min</td>
</tr>
<tr>
<td></td>
<td>9 min</td>
</tr>
<tr>
<td></td>
<td>12 min</td>
</tr>
<tr>
<td></td>
<td>15 min</td>
</tr>
</tbody>
</table>

(The Table 1. Independent variables and ranges)

The independent variable ranges are as follows. The number of wraps was varied from a single wrap to the full Robert Jones (3 wraps). The seam location was varied from the center of the pad on the break to center of the pad 6 inches above the break. The overlap was tested at 2 and 6 inches. The single wrap and the full Robert Jones were tested for each condition.
Experimental procedure:

**Single layer Robert Jones procedure:**
1. It is important to remain meticulously consistent in your wrapping methods. Use 14 inch cotton pads for wraps and 3 inch ace bandages. Start every wrap on the corner away from you on the top.
2. Start the first layer by evenly splitting the joint with the first cotton pad and wrap it around the post on top of itself.
3. Use 3 inch Ace bandage to overlay cotton wrap starting 1 inch from the top and spiraling evenly to 1 inch from bottom of the pad.
4. Start with the second pad lower on the leg, overlapping 2 inches on the first.
5. Wrap the second 3 inch Ace bandage starting 1 inch from the bottom of the pad spiraling evenly up the pad ending on the first wrap.
6. Measure the initial height of the post. Remove support and measure the new height after the initial displacement.
7. Immediately and gently add a 2lb weight and measure the new height.
8. Measure the displacement at 3 minute intervals for 15 minutes.
9. Do 4 tests at each position.

**Second and third layer Robert Jones procedure:**
1. Start the next layer directly over the first cotton pad.
2. When wrapping the third ace bandage, start from the top instead of the bottom.
3. As the wrap gets larger in diameter you have to use less overlap of the ace bandage for each spiral.
4. Continue to finish each layer as depicted above in steps (4-8).

**Change of seam location Robert Jones procedure:**
1. Move the first pad up the beam by 2 inches (so now you have 9 inch on one side of the hinge and 5 inch on the other.)
2. Repeat the same steps (3-9) of the single layer Robert Jones procedure.
3. Repeat this procedure moving another 2 inches up the beam until you have data for centered, 2, 4, and 6 inch offset.
Change of overlap procedure:
1. Wrap according to initial procedure except overlay the second cotton pad 6 inches as opposed to the original 2 inches (in step 4 of basic procedure).
2. Repeat all other steps the same.

Data Reduction Procedure:

Data is gathered in sets of 4 replicates, varying the wrap method with each set. Deflection of the beam will be measured with consistent loading over time as a function of overlap, offset, and number of wraps. These parameters are to be analyzed in Minitab by general factorial analysis for statistical significance. Human error is eliminated by assigning a person to wrap bandages as consistently as possible.

Results/Discussion:

To analyze our data we used an ANOVA table to discover whether the changes due to each variable were statistically significant. (See Table 2 below) The significance is to a 95% confidence level. As interpreted from the ANOVA table, the number of wraps is extremely significant as well as the overlap. Load also contributes significantly to the amount of deflection, but it is not a variable for the wrapping method. The only significant interaction shown is that between loading orientation and number of wraps, which is to be expected.
### General Linear Model: ANOVA Table

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Seq SS</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>5</td>
<td>110.143</td>
<td>2.257</td>
<td>0.451</td>
<td>0.80</td>
<td>0.551</td>
</tr>
<tr>
<td>Wraps</td>
<td>2</td>
<td>818.124</td>
<td>119.811</td>
<td>59.906</td>
<td>106.25</td>
<td>0.001</td>
</tr>
<tr>
<td>Offset</td>
<td>2</td>
<td>3.459</td>
<td>2.546</td>
<td>1.273</td>
<td>2.26</td>
<td>0.108</td>
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<tr>
<td>Overlap</td>
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<td>17.736</td>
<td>4.399</td>
<td>4.399</td>
<td>7.80</td>
<td>0.006</td>
</tr>
<tr>
<td>Load</td>
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<td>56.391</td>
<td>11.875</td>
<td>11.875</td>
<td>21.06</td>
<td>0.001</td>
</tr>
<tr>
<td>Time*wraps</td>
<td>10</td>
<td>56.794</td>
<td>5.308</td>
<td>0.531</td>
<td>0.94</td>
<td>0.497</td>
</tr>
<tr>
<td>Time*offset</td>
<td>10</td>
<td>0.625</td>
<td>0.120</td>
<td>0.012</td>
<td>0.02</td>
<td>1.000</td>
</tr>
<tr>
<td>Time*overlap</td>
<td>5</td>
<td>0.952</td>
<td>0.305</td>
<td>0.061</td>
<td>0.11</td>
<td>0.990</td>
</tr>
<tr>
<td>Wraps*load</td>
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<td>27.988</td>
<td>23.636</td>
<td>11.818</td>
<td>20.96</td>
<td>0.001</td>
</tr>
<tr>
<td>Offset*load</td>
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<td>0.113</td>
<td>0.176</td>
<td>0.088</td>
<td>0.16</td>
<td>0.856</td>
</tr>
<tr>
<td>Overlap*load</td>
<td>1</td>
<td>0.119</td>
<td>0.119</td>
<td>0.119</td>
<td>0.21</td>
<td>0.647</td>
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<tr>
<td>Error</td>
<td>182</td>
<td>102.615</td>
<td>102.615</td>
<td>0.564</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>223</td>
<td>1195.061</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*(Table 2) ANOVA*

Shown below in Figure 2 are the individual effects on the deflection observed by changing each variable independently. The change in the individual variable is shown on the horizontal axis while the amount of deflection is on the vertical axis. Time is in seconds; lengths are in inches and load orientation is without and with a 2 pound load.
The data shows that the number of wraps provides the most significant change in the amount of deflection and thereby the most significant change for the amount of support given. The effect of offset remains consistent up to 2 inches, but appears to reduce deflection when increased to 4 inches. This result, however, turns out to be statistically insignificant. As expected, increasing the load on the end of the beam causes more deflection. This allows us to exaggerate the amount of deflection shown by the change of support from the other variables.

We measured the amount of creep due to time over 15 minutes. Since the wrap will be on a horse for up to 24 hours it is important to see how the wrap behaves over time. As shown, the most significant change in deflection occurs within the first 3 minutes and then begins to level off. By 15 minutes the deflection change is nearly zero.

Another effect measured was the overlap. We tested the “normal” process of using a 2 inch overlap of cotton pads and then tested it using a 6 inch overlap. This was probably
our most surprising result as there was a significant effect caused by overlap. As shown in the graph, we observed a smaller deflection when wrapping with the larger overlap.

In Figure 3 you can see the plots of interaction. Together with testing each parameter individually, we also tested the different independent variables at the same time to see if there was any interaction. We used the “Lo Hi” method testing the smallest and largest levels of overlap and offset with both the single and the full wrapping method.

(Figure 3) Plots of interaction.

There is no noticeable interaction between factors and time, meaning no style of wrap was more or less effected by time. The only significant interaction is between number of wraps and load, which is expected to be similar to springs. There is a noticeable difference between the amount of change in deflection seen by the single, double and triple wrap when you add a greater load, which can be thought of as changing the spring constant. As the ANOVA table shows this is the only significant interaction (to 95% confidence.)
Accuracy:

Elevation of the free end of the test apparatus is determined with a yard stick (resolution 1/8 inch). The measurements could contain error due to human error with the wrap procedure, or the measurements of the offset of the wrap. We attempt to keep the human error constant by designating a person for wrapping the bandages, and implementing a procedure to wrap consistently.

Conclusion:

In conclusion we found the bandage wrapping style to have a very significant effect on the amount of support given by the Robert Jones Bandage. The most significant factor is the number of wraps used. We recommend using the full 3 wrap for best results. We also recommend a 6 inch overlap between wraps when possible. It is not nearly as important, but still adds significant support over the normal 2 inch overlap. The offset of the center of the first cotton pad on the break is not significant as long as you are within 4 inches of the center. This result tells us that precisely locating the break is not a key factor with regard to the strength of the bandage. Outside of 4 inches of offset the support breaks down and our recommendations are no longer valid.
Bibliography