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Novel semi-automatic tool for spinal cord removal form ovine carcasses

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Abstract

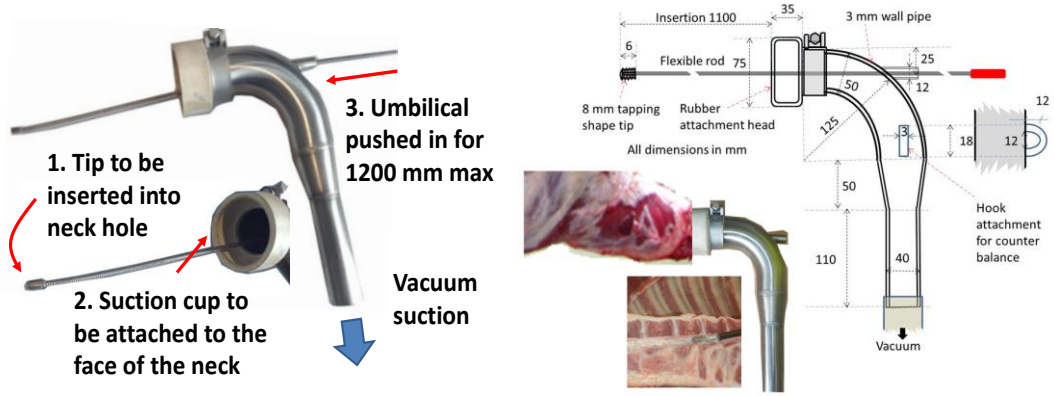
High quality ovine production, in particular lamb for the Australian domestic market, requires the primal and sub primal pieces to be free of high risk tissues such as spinal cord. In many plants after the breakup of lamp the loin, rack and square cut shoulder primal pieces are trimmed to meet customer specification and between 10%-15% of a butchers time as a knife hand, is spent separating and disposing of the spinal cord per piece. This project has been concerned with efficiencies that may be gained from carrying out such tasks early in the operation to avoid tedious work in the boning room. A tool that can be used with automatic suction to remove the spinal cord from whole lamb carcasses at the end of the slaughtering process, before the chill, has been developed and tested. It uses a ‘snake’ type umbilical, which is hand inserted into the spinal cavity from the neck end and propagated by a pushing action up the spine whilst a cup attachment in a vacuum circuit, attached to the neck, takes out the spinal cord. The innovation is the manner in which the umbilical and the suction tool are integrated into a working tool with a specific tested tip. The research results have spin off benefit for the development of a similar tool for removal of spinal cord from beef carcasses before splitting.

Executive summary

High quality ovine production, in particular lamb for the Australian domestic market requires the primal and sub primal pieces to be free of high risk tissues such as spinal cord. In many plants after the breakup of lamp the loin, rack and square cut shoulder primal pieces are trimmed to meet customer specification and between 10%-15% of a butchers time as a knife hand, is spent separating and disposing of the spinal cord per piece. Many plants split Primal pieces such as the loin barrel and the shoulder primal using a band-saw and the spread of cord tissue is unavoidable. Knife operators, trimming or deboning, separate the spinal cord by hand given the access to the split face of the primal pieces.

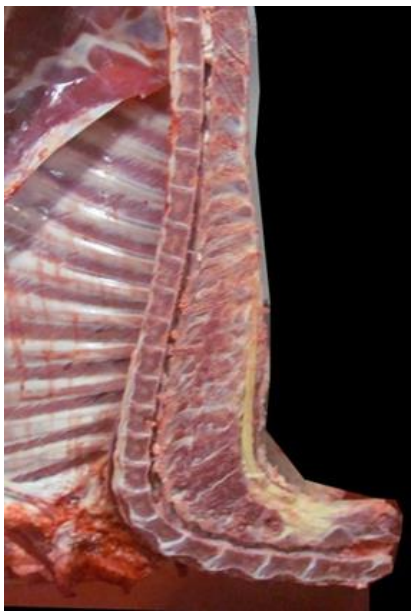
The scope of this project has been to build and test a prototype hand operated cord removal tool, with an off-the-shelf vacuum system, to remove cord from the spinal column of a whole lamb carcass just before the end of the slaughter line.

The figures below shows the schematics of the tool with images showing a test result and the manner in which the tool and the suction head would operate. Note that the tool needs to provide only for removal of spinal cord from the neck entry to a point up along the spinal column, just passed the position of the cut that separated the leg from the loin.



Lamb carcass cord removal tool developed and tested

A 10%-15% improved efficiency among 5-7 knife hands is considered significant. The cost of the tool is not expected to be higher than AU$60,000, when commercially designed and built, including the vacuum system and cord collection vessels already available from Freund in Germany. The ROI is expected to be less than one year based on efficiency and gains from quality and containment of high risk cord material would be additional. Steps are being taken for commercial implementation of the solution for further trials in an Australian plan to facilitate adoption by Australian processors. The results have spin off benefit in the development of a similar tool for removal of spinal cord from beef carcasses before splitting. It is important to note that in beef, the savings would be much greater has higher numbers of staff are committed to the removal of spinal cord.



Cord removed prior to splitting. Image shows the split face.

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1. Background

High quality ovine production, in particular lamb for the Australian domestic and export markets, requires the primal and sub primal pieces to be free of high risk tissues such as spinal cord. In many plants after the breakup of lamp the loin, rack and square cut shoulder primal pieces are trimmed to meet customer specification. Observations in a typical cutting room processing lamb reveals that several butchers use their knife after primal pieces, such as shoulder and loin, are split on a band saw along the spine, to remove the spinal cord. The task of removal of such risk material may be considered somewhat too late in the operation as splitting on a band-saw causes spread of such tissue material prior to trimming or de-boning. It has been considered that the removal of spinal cord before the carcass is spilt would bring significant advantages. In addition to containment and effective removal, the process of cord removal from a whole carcass would save time from butchers engaged in important cutting, boning and trimming tasks, thus improving efficiency. Between 10%-15% of butchers' time as a knife hand, is spent separating and disposing of the spinal cord per piece. The Cord Removal Tool (CRT) would eliminate the need for this work in the cutting room.

This project has been instigated with AMPC and in kind support of meat processors and machine suppliers, to build and test a prototype hand operated cord removal tool, with an off-the-shelf vacuum system, to suck the cord out from the spinal column of a whole carcass, whilst still hot, just before the end of the slaughter line.

The input and support of all concerned, including AMPC, MLA and processors in Australia, especially GM Scott and Midfield Meat, is gratefully acknowledged.

2. Project objectives and methodology

The objective has been to reach a design solution and conduct testing of a prototype tool in a test environment that shows functionality of the tool in removing spinal cord form lamb carcasses at the end of the slaughter operation prior to entry into chill rooms. The tool is intended to be used on carcasses that are whole with the tool tip entering through the neck hole in the spinal cavity. The methodology applied has defined the variability in the process based on an evaluation of carcass size variability. A selection of tool tips have been trialled leading to the definition of single tip profile that has performed well in trials with meat sections. The path along the neck in the shoulder, where spine curvature can be most acute, presents the most challenge. A step by step assessments in the design procedures has led to a practical and cost effective tool that may be used by meat processors, once commercialised. Testing under simulated conditions has supported the selection of tool design process and estimation of time cycle for the removal of cord material from lamb carcasses. The process of first insertion of the tool is manual as automated solutions will be costly and testing has shown that if the propagation of the tool by hand is assisted by a powered device, the tool tip finds an alternative path between the vertebra, not following the spinal cavity, whilst passing the curved section of the in the shoulder area. The tool tip shape is the critical factor in this process combined with the operator judgement in propagating the tool along the spine cavity from the neck hole.

3. Results and discussions

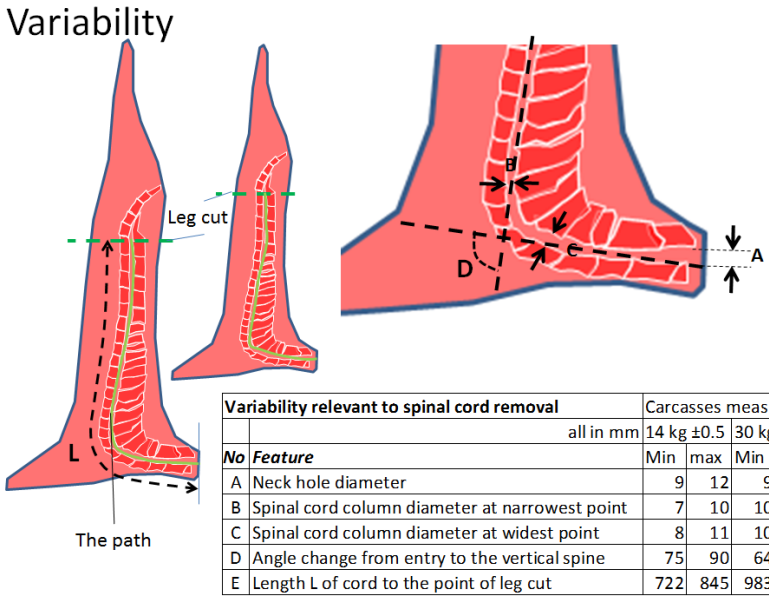
The research has systematically investigate and quantify the key drivers supporting the design and development following a methodical approach including:

i) Assessment of variability in ovine carcasses supporting the definition of:
   a) vacuum tube size and profile
   b) umbilical length and features for easy propagation after insertion
   c) ergonomic tool design features in respect of manual positioning of the tool
   d) attachment process as affected by the variability for efficient and fast operation

ii) Tool concepts for easy attachment to the carcass at neck point and automatic insertion of the tube up the spinal cavity. The important parameters being:
   a) Weight and size of the complete tool for easy handling
   b) Fast attachment involving easy manual handling in the initiation of the procedure
   c) Cycle speed for tool engagement and cord removal from the moment of insertion, penetration, retraction and detachment
   d) Sterilisation of the tool within the total cycle time.

3.1 Variability in the carcass influencing the CRT design

Figure 3.1 shows the important features that have an influence in the design considerations of the CRT.



Variability relevant to spinal cord removal		Carcasses measured			
	all in mm	14 kg ±0.5		30 kg ±0.5	
No	*Feature*	Min	max	Min	max
A	Neck hole diameter	9	12	9	14
B	Spinal cord column diameter at narrowest point	7	10	10	12
C	Spinal cord column diameter at widest point	8	11	10	12
D	Angle change from entry to the vertical spine	75	90	64	86
E	Length L of cord to the point of leg cut	722	845	983	1145

Figure 3.1 Variability in the profile of the spinal cavity for different lambs

The path length, L determines the size of the umbilical, which needs to be 1200 mm plus the length of the suction head section, to be designed as short as possible, and a small length for handling the umbilical. See Figure 3.1(E).

The change of angle form entry (Figure 3.1 D) has a important impact on the flexibility of the umbilical, allowing it to bend in order to pass through the spinal cavity in the shoulder region. The dimensions A, B, and C as in Figure 3.1, are critical for the definition of the umbilical and the tip design. Note that the 90 degree angle change from the point of entry causes complication for any kind of powered assisted process for the insertion of the umbilical tool. Trials have revealed that the tool penetrate the carcass not following the spinal cavity when a powered device is used to assist with pushing action by linear thrust or rotational motion. The option to use a power driven tool has thus been eliminated in the CRT design process.

3.2 Cord Removal Tool (CRT)

The features of the tool are shown in Figure 3.2. The umbilical is a flexible but springy cable that has a special tip designed after consideration of a variety of tip shapes. The tip is required to allow the umbilical to travel along the spinal cavity, guiding it along the right paths in different carcasses, whilst breaking the cord tissue as it is moving forward. The breaking of the cord makes the process of suction more effective with the carcass still hot at the end of the slaughter line.

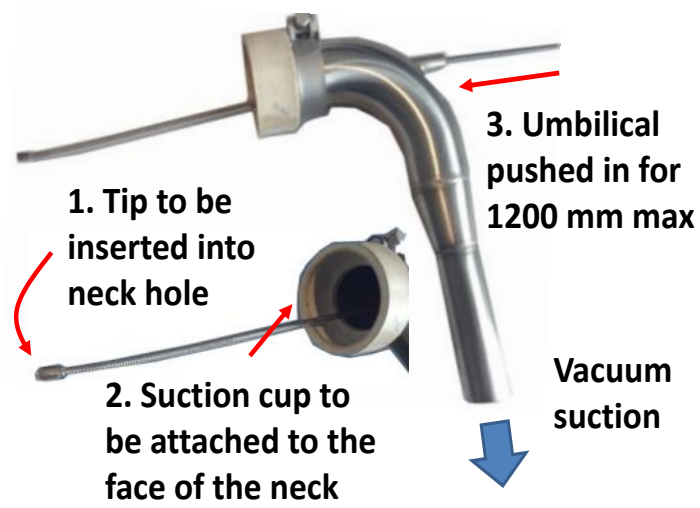


Figure 3.2 Lamb carcass cord removal tool developed and tested

The tip has the profile of a 'tapping tool' where the ridged section on the round edge, as in Figure 3.3, scrapes on the inside of the spinal cavity to separate the cord from the spine. The blunt tip avoids penetration into the cavity and the tapered shapes helps the tool travel up the spinal channel. The curved section of the tip allows material to be sucked passed the tip in the reverse direction of travel. Figure 3.4 gives the assembly of the tool with the prototype also shown. The tool definition has been reached after a number of iterative attempts to optimise the shape, weight and profile the rubber attachment as the face of the head needs to map different neck surfaces for proper vacuum connection. The weight of the tool may be supported by a counter balance, as the vacuum tube connected to the CRT could require undue effort from operator using the CRT during a full working day.

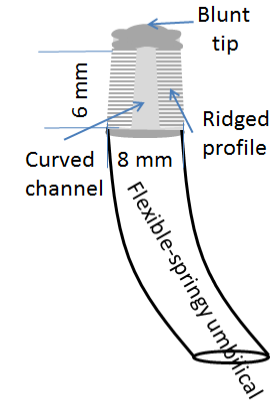


Figure 3.3 CRT Tip

Figure 3.5 illustrates the expected action from an operator placing the tool tip at the neck entry with partial penetration of the tip into the cavity and the attachment

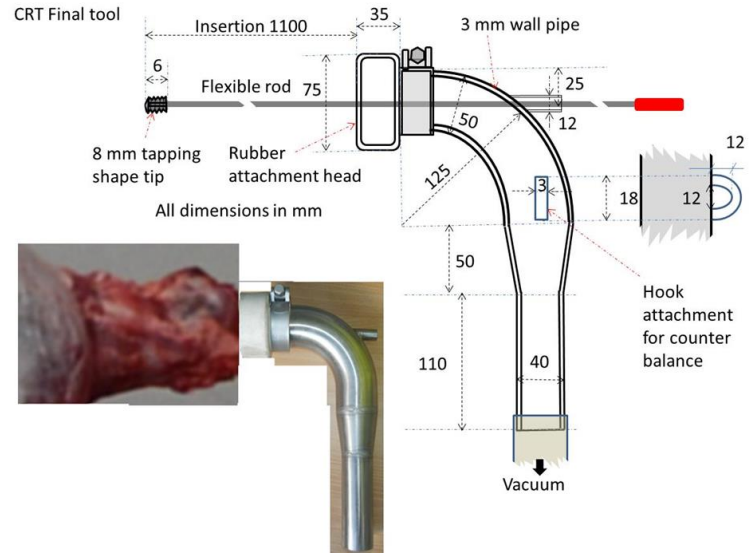


Figure 3.4 Final CRT design and prototype

of the cup, followed by full penetration of the umbilical and retraction. Note that the tool would be in use after all veterinary inspection and clearances, with the position of the station being just before the grading station, thus avoiding the need for the CRT requiring sterilisation in between carcasses.

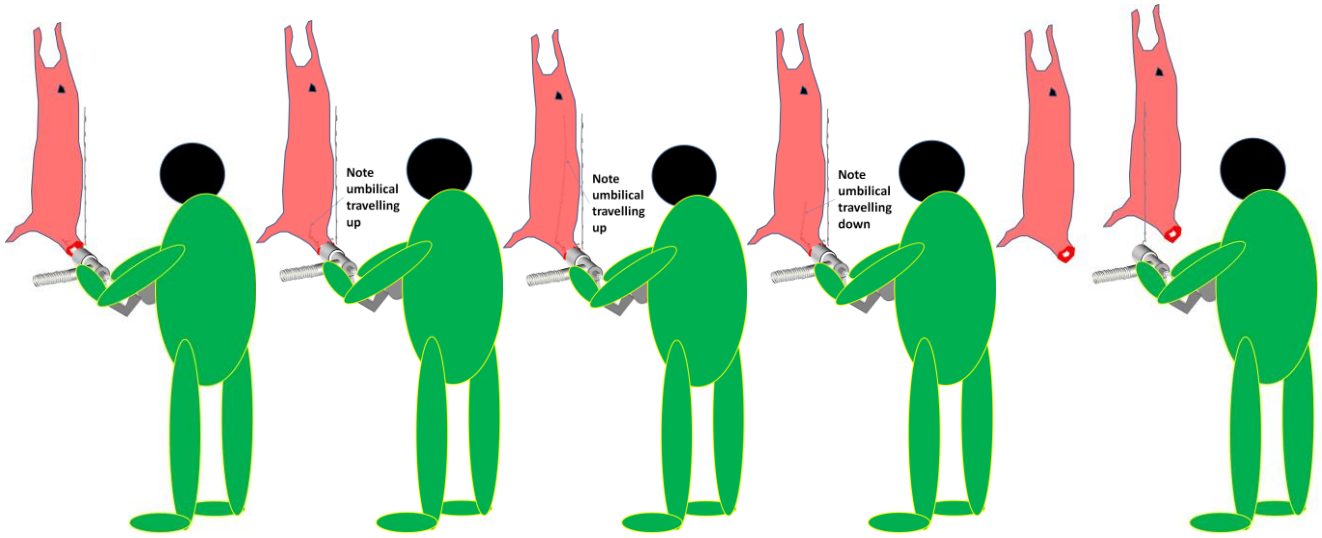


Figure 3.5 Attaching the tool: a) insert tip, b) attach cup, c) fully insert and retract umbilical, d) detach.

3.3 Testing

Testing with carcasses and carcass sections, mainly the shoulder primal as the propagation of the tool in this region of the carcass has presented the most challenge, has been carried out. Figure 3.6shows images of the tool during testing.

Figure 3.6 Testing of CRT.

The testing with carcasses has been with the Freund vacuum system as in Figure 3.7.

The full in its final commercial form would provide the following:

i) A self-contained CRT tool as in Figure 3.4 with a umbilical not greater than 1.5 meters.
ii) A counter balance mechanism to suspend the tool
iii) A Vacuum system as in Figure 3.7.

The CRT as presented has appropriate ergonomic design for easy use by an operator to carry out the

Figure 3.7 Freund Vacuum system

tasks of attachment, insertion and separation with an estimated cycle of 8-10 seconds. Further validation of this cycle time will need to be made once a commercial unit is available for testing online.

Note that the vacuum system from Freund has been used and especially supplied for this project. The system has special features which also collect the spinal cord in a suitable chamber for containment and handling.

4. Concluding remarks

A tool that can be used with automatic suction to remove the spinal cord from whole lamb carcasses at the end of the slaughtering process, before the chill, has been developed and tested. It uses a 'snake' type umbilical, which is hand inserted into the spinal cavity from the neck end and propagated by a pushing action up the spine whilst a cup attachment in a vacuum circuit, attached to the neck, takes out the spinal cord. The innovation is the manner in which the umbilical and the suction tool are integrated into a working tool with a specific tested tip. The research results have spin off benefit for the development of a similar tool for removal of spinal cord from beef carcasses before splitting. A 10%-15% saving of a butchers' time, as knife hands, to separate and contain the spinal cord in the cutting and trimming area will provide a saving that equates to a 12 month return on investment against an investment in the equipment including the vacuum system.