PEER REVIEWED

Forces Exerted by Hydraulic Cattle Chutes

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Abstract

To describe the magnitude and variability of forces generated, we measured peak forces at nine different locations in hydraulic chutes used for cattle restraint. The headgate, middle of the chute, and tailgate were each measured at 18, 34, and 48 inches from the chute floor using a 3,000 lb capacity, high accuracy S-beam load cell. Peak forces generated by hydraulic chutes ranged from a low of approximately 100 lb to a high of over 3000 lb. There were large variations in forces observed within and between facilities, with the coefficient of variation on chute forces across all chutes at approximately 50% for all positions assessed. At 34 inches from the floor, 43, 14, and 29% of chutes generated less than 600 lb of force at the headgate, middle, and tailgate, respectively, while 29, 50 and 21% of chutes generated greater than 1000 lb of force at the headgate, middle, and tailgate, respectively. There is a large amount of variability in forces generated by hydraulic chutes used for cattle restraint. Some chutes generate forces potentially hazardous to cattle.

Introduction

Adjusting a hydraulic chute to render optimal force is frequently mentioned as an important consideration in working cattle gently and efficiently.[1,5,7] Guidelines for proper adjustment include that the animal be able to breathe normally and be held tightly enough to provide a feeling of restraint, without excessive, painful force.[1,5,7] However, there are few objective recommendations on what is optimal. Reports exist of excessive hydraulic chute forces resulting in cattle injury.[7] The purpose of this study was to describe the magnitude and variability of forces generated by hydraulic chutes used for cattle restraint.

Materials and Methods

The principle investigator contacted commercial and research cattle feedyards in the Texas and Oklahoma High Plains to obtain permission to measure their hydraulic chute forces. Fourteen hydraulic chutes at nine facilities were assessed.

A 3-inch wide, 3,000 lb capacity, high accuracy S-beam load cell[a] that took 13 readings per second was used to determine peak pounds of force applied when the hydraulic valve was held at bypass. The load cell was configured to store the peak reading until reset. Steel spanners, simulating cattle body widths, were threaded into the load cell. The free ends of the spanner were designed to conform to the chute with minimal slipping while force was applied.

Nine force points were measured on each chute. The headgate, middle of the chute, and tailgate were each measured at 18, 34, and 48 inches from the chute floor. The headgate and tailgate were measured at a width of 8 inches. The middle of the chute was measured at a width of 15 inches.

The chute was opened, the spanner/load cell was positioned, and a small amount of force was applied slowly to hold the spanner/load cell in place. After personnel retreated from the chute, the hydraulic valve was moved to the bypass position and held there until the load cell readout stabilized. The entire procedure was repeated three times for each of the nine locations. The average of the three values was used as the peak force measurement for that location.

A survey was administered to feedyard personnel to determine chute history. The survey included questions on chute manufacturer, model, and year manufactured; year installed; headgate description; approximated number of head processed; average weight of animals processed; post-manufacturing chute modifications; and chute force adjustments.

[a] Omega Engineering Model LCCA-3K, New York, NY

Results

Table 1 shows the average, minimum, and maximum peak forces for each of the nine locations measured in the 14 hydraulic chutes. Configuration of three chutes precluded measurement of middle chute force at 48 inches, as the chutes were wider than 15 inches at the top. At 34 inches from the floor, 43, 14, and 29% of chutes generated less than 600 lb of force at the headgate, middle, and tailgate, respectively, while 29, 50 and 21% of chutes generated greater than 1000 lb of force at the headgate, middle, and tailgate, respectively. The coefficients of variation (Table 1) ranged from 42 to 64%.

The survey results revealed this non-random sample included chutes used for arrival processing and reimplanting, sick cattle treatment, or both. Some chutes were used daily and others were used at intervals. Six chute manufactures were represented. Eleven chutes had scissors-type headgates and three had rotary-type headgates. Manufacture date ranged from 1983 to 1998, with one chute that was unknown. Eight chutes were known to have never had the force adjusted since manufacture, four chutes had the force adjusted up, and two chutes had unknown histories.

Discussion

In this study, we observed a range of peak forces generated by hydraulic chutes from a low of approximately 100 lb to a high of over 3000 lb. We also noted large variations in forces observed within and between facilities. Coefficients of variation on chute forces across all chutes were near 50% at all positions assessed.

Adjusting a hydraulic chute to render optimal force is frequently mentioned as an important consideration in working cattle gently and efficiently.[1,5,7] In a study[6] to determine if vocalization could be used as a simple, objective method for quantifying cattle discomfort, 98.2% of vocalizations occurred immediately after an observed aversive event. In two facilities, increased vocalizations were associated with faulty design and excessive force exerted by powered restraining devices.[6] There are anecdotal reports of severe injuries, such as ruptured diaphragm and fractured pelvis, resulting from excessive chute forces.[7]

Guidelines for proper adjustment include that the animal be able to breathe normally and be held tightly enough to provide a feeling of restraint, without excessive, painful force.[1,5,7] However, there are few objective recommendations on what is optimal. Recommended hydraulic system pressure for most commercially available squeeze chutes is 500 PSI to operate the squeeze sides.[5] Another recommendation is a middle section force of 600 to 800 lb at 27 inches above the bottom pivots for cattle weighing less than 600 lb and 1000 to 1500 lb for cattle weighing over 600 lb,[2] although the author of these recommendations now thinks they may be too high (Grandin, T., 1999, personal communication).

The only previous chute force survey the authors could find were measurements taken on 28 hydraulic chutes in 11 Arizona feedlots.[2,3] This study used a hydraulic load cell in a manner similar to the study reported here. The load cell was placed in the middle of the chute, 27 inches up from the bottom pivots, and measured a maximum of 2000 lb. Four chutes had middle chute forces at or above the load cell measuring limits. These chutes were reported to cause serious injuries[3] or even death (Grandin, T., 1999, personal communication). Fourteen chutes generated forces from 700 to 1,750 lb.

One source recommends a 32- to 36-inch distance between the chute floor and the widest part of the neck opening.[3] We measured a number of locations on each chute. The 34-inch reading reported here should represent the correct and most common force a calf will experience on its head and neck. At the headgate, these ranged from 226 to 1726 lb. Fifty percent of chutes exceeded 1000 lb of force in the middle of the chute at 34-inch above the floor, while only 14% of chutes were below the recommended forces for calves weighing less than 600 lbs.[3]

Variability of individual cattle behavior results in a variety of cattle body parts being caught in virtually all locations in a hydraulic chute. Hence, we also as-

Table 1. Force readings from nine locations in 14 hydraulic chutes.

Location	Head Gate			Middle of the Chute			Tail Gate		
Inches from chute floor	18	34	48	18	34	48	18	34	48
Average (lb)	1444	819	636	1414	958	690	1542	846	634
Minimum (lb)	169	226	209	257	140	404	85	201	142
Maximum (lb)	3037	1726	1133	2636	1700	1308	3251	1625	1190
Standard Deviation (lb)	920	451	280	680	431	291	891	422	299
Coefficient of variation (%)	64	55	44	48	45	42	58	50	47

sessed forces at 18 and 48 inches from the chute floor. These should approximate the extremes experienced for individual cattle not caught cleanly. Given the lever nature of hydraulic chutes, the lower the measurement, the higher the peak force. For headgates and tailgates at 18 inches from the chute floor, where heads and legs could be accidentally caught, forces exceeding 3,000 lb were observed.

We report peak force, rather than pressure (force per body area). From a practical standpoint, force per square inch is difficult to interpret and use. Animals initially caught incorrectly might have their head, leg, or shoulder squeezed instead of their neck. Likewise, some chute operators use the rear door to regulate cattle flow into the chute. Either purposefully, or accidentally, heads, necks, legs, and bodies are caught in rear doors of hydraulic chutes. Forces per square inch would vary greatly in these different situations.

At least two items seem to be lacking when considering the current situation. First, a practical method is needed to provide chute operators with information on the amount of force applied to the animal. Second, data is needed correlating high or low chute forces with good or bad outcomes such as injury rate, subsequent growth performance, processing efficiency, or implant defects.

While attitude of management is the single most important factor determining how animals are treated,[4] providing properly designed and adjusted cattle handling equipment facilitates proper handling. Further research is needed to determine optimum forces for hydraulic chutes.

Conclusions

There is a large amount of variability in forces generated by hydraulic chutes used to restrain cattle. Some chutes generate forces potentially hazardous to cattle.

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Abstract

Effects of dry cow intramammary therapy on quarter infections in the dry period

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Quarter milk samples were taken from 150 cows from three dairy farms in south-east Queensland at drying off, two, four and six weeks after drying off, at calving, and one, two and three weeks after calving. In each of the herds, the cows were randomly allocated to three groups of approximately equal size. One group had all the quarters of all the cows treated at drying off with a dry cow antibiotic infusion containing cloxacillin; the second group was given no treatment, and the third group had selected quarters treated on the basis of their high activity of N-acetyl-ß-D-glucosaminidase at drying off. Dry cow treatment resulted in a marked reduction in the number of infected quarters at two and four weeks after drying off, so that the comprehensively treated group had significantly less infected quarters at these times ($P<0.02$). Twelve clinical cases of mastitis were detected two weeks after drying off in the untreated groups, 10 in the untreated quarters of the selectively treated groups, and no cases in the comprehensively treated groups. These cases were due mainly to *Streptococcus uberis* and *Streptococcus dysgalactiae*. The number of infected untreated quarters increased markedly between drying off and two weeks later, but in all three groups there was a marked decrease in the number of infected quarters between six weeks after drying off and calving, suggesting that the mammary glands were more able to overcome infections at this time.