Indian J. Vet. Med. Vol. 37, No. 1&2, 2017 pp. 17-23

Teat ultrasonographic assessment of milk flow disorders in hand milked dairy cows

M.Venkatesan[1], P.Selvaraj[2], D.Sumathi[3] and R.Arun[4]

[1]Assistant Professor, [2]Professor and Head, Department of Veterinary Medicine, Veterinary College and Research Institute, Orathanadu, Thanjavur, Tamil Nadu - 614 625

[3]Assistant Professor, Department of Veterinary Clinical Medicine, Madras Veterinary College, Chennai-600007.

[4]Subject Matter Specialist (Animal Science) Krishi Vigyan Kendra, Karur, Tamilnadu.

Abstract

While many studies had been done on teat morphology of machine milked animals, no major studies are available for hand milked cows. Interpretation of ultrasonographic measurement is very crucial for better understanding on the recovery of teat tissue before and after milking. Towards this ultrasonographic assessment of teat morphology was undertaken on 32 hand milked cows. Milk Flow Disorders were diagnosed in 23 (71.86 %) cows. Ultrasonography of the teat was found to have better diagnostic yield in the detection of Milk Flow Disorder (64.28 %) when compared to clinical detection (35.75 %) as well as in location of the lesion and in identifying the type of lesion.

Keywords: Ultrasonography, Hand milked cows, Milk Flow Disorder,

Ultrasonography is increasingly used in Large Animal Medical Practice for the diagnosis of anatomical, pathological and physiological conditions of all parts of the mammary gland (teat and parenchyma). The application of ultrasound in the evaluation of milk flow disorders is emerging and is a biggest challenge in developing countries like India, where in hand milking is the most common among farmers. There are lots of studies carried out on mastitis but only a few studies were carried out on milk flow disorders. Many of the ultrasound studies are done in machine milked cows, but not in hand milked cows. This study reports the ultrasonographic assessment of milk flow disorders in hand milked dairy cows.

Materials and Methods

The present research work was carried out in Madras Veterinary College, University Research Farms and private dairy farms in and around Chennai. After a screening of 450 cows for milk flow disorders and with mastitis, 32 animals were selected for ultrasonographic study. Based on milk yield they were divided into low, medium and high yielders. Physical examination as well as Ultrasonographic examination of udder and teat was performed to identify the Milk flow disorder, location of the lesion and type of lesion by water bath technique using Esaote Mylab-20 Ultrasound Station with 5.0 MHz convex and 7.5 to 12.5 MHz linear transducers, respectively (Fig.1). Using 7.5 to 12.5 MHz linear probe ultrasonographic morphometry (teat canal length-TCL, teat wall thickness-TWT, and teat end width-TEW and teat cistern width-TCW) were evaluated on normal teats and milk flow disorder affected teats, before and after hand milking. Milk samples were collected from all the quarter for mastitis testing.

The data obtained were subjected to statistical analysis as per Snedecor and Cochran (1994). The statistical software package – SPSS 20.0 for windows was utilized and the results were analyzed based on one way ANOVA, Duncan's technique, t-test and Chi-square test.

Results and Discussion

Out of 32 animals assessed with Teat Ultrasonography, 23 cows were found to have Milk flow disorders (MFD) and the remaining 9 were without Milk flow disorders. Out of 128 teats examined in the present study, 28 teats were found to have milk flow disorders. Milk flow disorder was found to affect all quarters, almost equally (left fore = 6, left hind = 8, right fore = 8, right hind = 6).

The mean values of ultrasonographic variables of healthy teats (left fore and left hind teat as well as right fore and right hind teats) before and after milking in low, medium and high yielders are presented in Table Ia,b (Fig.2a & 2b). The values for affected teats, are presented in Table IIa,b (Fig. 3a, 3b).

In present study the types of lesions identified in quarters with Milk Flow Disorders included intraluminal growth, teat cistern growth, milk clots, teat fistula, tip injury and covered teat injury each. Teat cistern mucosal growth type of milk flow disorder was encountered at higher percentage 35.71(10/28) followed by teat tip injury, covered teat injury 17.85 (5/28). Franz *et al.,* (2009) reported of similar findings. Milk flow disorders are the main indications for ultrasonographic examination of the teat. Teat injuries, improper milking technique and partial or total teat stenosis are common reasons for the disturbance of milk flow in dairy cows (Selvaraj *et al*., 2016).

In this study the teat canal length and teat wall thickness were found to be increasing in the entire teat after hand milking (Table Ia, b). Similar findings were reported for machine milked cows by various authors (Zecconi *et al.,* 1992; Neijenhuis *et al*., 2001; Gleeson *et al.,* 2005 and Stojnović and Alagić 2012). The increase in the measurements indicates that the time taken for recovery of the teat to normalcy was more, thereby exposing the teat for possible infections. Various authors have discussed about the teat recovery time. Recovery time of teats is interpreted as the time that it takes for the teats to decrease the penetrability of the teat canal to endotoxin or teat canal diameter after milking (Hamann and Burvenich, 1994; Schultze and Bright, 1983; McDonald, 1975). Teat-canal penetrability is an important parameter for management aspects as with increased teat penetrability the possibilities for infections are more. Hence animals need to be allowed to stand for 1-2 hours after milking so as to avoid contact of the teat with the bedding materials and/ or floor.

The teat penetrability is dependent on the biochemical composition of the teat tissue, the opening of the sphincter, and the changes in teat tissue. The teat permeability cannot be studied with ultrasound. However, it is assumed that teat tissue changes could reveal teat-canal penetrability. To establish the relationship between teat-canal penetrability and changes in teat thickness, it requires advanced ultrasographic techniques and assessment and need to be studied further.

The teat cistern width had varying pattern (Table Ia, b) in different types of yielders. However the changes were not statistically significant. Neijenhuis et al. (2001) observed that, the teat end width had different patterns after milking in machine milked cows. Similar findings were observed in this study with hand milked cows. The reason for such changes might be due to the fact that measurement was being carried out at the most pliable part of the teat, which is difficult to be held during measurement. This study was carried out at different places in Chennai where the farmers practiced hand milking. The technique of milking (stripping or by full hand method) by different milkers could also influence the teat canal width. This could also be attributed to improper milking and or complete or incomplete milking.

The teat end width in various yielders was found to be decreased after milking in the entire teat. This was divergent from the findings of Neijenhuis *et al.,* (2001). Current study was conducted with hand milked animals whereas the other studies referred were conducted on machine milked animals. Again this present study comprised of mixed breed population at different places where as the referred studies were carried out on Holstein cows from a particular farm. Differences in breed characteristics in the teat morphometry and genetic selection might also be a reason for such differences and further studies in this regard in our Indian animals and breeds needs to be undertaken.

The teat wall thickness and teat cistern width change through the milking process in opposite directions (as cistern decreases in dimensions the teat-wall thickness increases), as the milk is withdrawn from the teat cistern during milking (Neijenhuis *et al*., 2001). Similar observations were noticed in this study except for the left fore teat in both low and high yielders, right fore teat in high yielders and right hind teat in medium yielders where in they did not show any changes. These few insignificant differences could be overseen as these measurements were carried out at the most pliable part of the teat. Fluctuation was seen with the ratio between teat-wall thickness and teat-cistern width. While no explanation could be given for this, few authors (Schultze and Bright, 1983; McDonald, 1975) used endotoxin penetrability or radiography, and observed a similar pattern.

In the current study the teat canal length and teat wall thickness had comparable increase in the entire teat after milking in both MFD affected and unaffected teats (Table IIa, b). The pattern was different in various teats with regard to teat canal length when compared between MFD affected and unaffected group. In MFD unaffected group the after milking values of left fore teats and left hind teats were higher than the MFD affected group where as it was found to be reverse in the right fore and right hind teats. The teat wall thickness was found to be more in fore teats compared to hind teats

Table: ia. Mean±se values of fore teat ultrasonographic variables before and after milking

		Low yielders				Medium yielders				High yielders				
		BM (mm)	AM (mm)	D (mm)	D%	BM (mm)	AM (mm)	D (mm)	D%	BM (mm)	AM (mm)	D (mm)	D%	F-value
TCL	LF	10.18 ±0.45	10.35 ±0.40	0.17 ±0.21^{a}	1.66	10.4 ±0.70	11.77 ±0.96	1.32 ±0.74^{a}	12.7	13.36 ±0.49	14.70 ±0.98	1.34 ±0.76^{a}	10.0	1.623^{NS}
	RF	10.99 ±0.89	11.16 ±0.98	0.17 ±0.15^{a}	38.7	12.83 ±1.64	13.34 ±1.70	0.51 ±0.27^{a}	3.9	13.50 ±0.91	14.13 ±0.79	0.62 ±1.064^{a}	4.6	0.154^{NS}
TWT	LF	7.51 ±0.31	7.62 ±0.25	0.11 ±0.17^{a}	1.5	7.73 ±0.57	9.18 ±0.52	1.44 ±0.16^{b}	18.6	7.25 ±0.45	7.56 ±0.39	0.31 ±0.67^{ab}	4.3	3.1401^{NS}
	RF	7.92 ±0.61	8.82 ±0.57	0.89 ±0.56^{a}	11.2	6.94 ±0.81	8.95 ±0.84	2.01 ±0.59^{a}	28.9	7.75 ±0.90	8.00 ±0.71	0.25 ±0.96^{a}	3.2	1.2461^{NS}
TCW	LF	9.63 ±1.34	10.08 ±1.23	0.45 ±0.67^{a}	4.67	10.38 ±1.09	9.73 ±1.21	-0.65 ±0.80^{a}	-6.26	6.86 ±1.17	8.60 ±0.79	1.74 ±1.16^{a}	25.3	0.538^{NS}
	RF	9.04 ±0.99	8.79 ±1.64	-0.25 ±0.90^{a}	-2.76	10.00 ±1.54	8.57 ±1.56	-1.43 ±0.84^{a}	-14.3	8.62 ±0.65	9.25 ±1.58	-0.63 ±1.6^{a}	-7.3	0.164^{NS}
TEW	LF	21.75 ±0.74	20.04 ±1.21	-1.71 ±1.08^{a}	-7.9	20.74 ±0.75	20.56 ±0.81	-0.17 ± .35^{a}	-0.82	21.51 ±0.72	20.62 ±0.57	-0.89 ± 0.21^{a}	-4.1	0.873^{NS}
	RF	21.96 ±0.73	21.36 ±0.69	-0.603 ±0.12^{a}	-2.7	21.73 ±0.54	21.64 ±0.47	-0.08 ± 0.34^{a}	-0.37	23.1 ± 1.17	21.87 ±0.81	-1.25 ± 0.59^{a}	-5.4	2.049^{NS}
TWT/	LF	0.95 ±0.14	1.10 ±0.15	0.15 ±0.03^{a}	15.7	0.86 ±0.11	1.27 ±0.13	0.41 ±0.09^{a}	47.7	0.91 ± 0.12	1.17 ± 0.22	0.27 ± 0.19^{a}	29.7	1.352^{NS}
TCW	RF	1.05 ±0.23	1.32 ±0.23	0.27 ±0.11^{a}	25.7	0.68 ±0.14	1.28 ±0.27	0.6 ± 0.20^{a}	88.2	0.88 ± 0.20	1.12 ± 0.22	0.23 ± 0.29^{a}	26.1	0.815^{NS}

** ($P<0.01$) – Statistically highly significant, * ($P<0.05$) – statistically significant, NS ($P>0.05$) - Statistically non significant, Mean bearing same superscript are not differed significantly; [Low yielders (LF and RF n= 11, and 10 respectively); Medium yielders (LF, and RF n= 7 and 6 respectively); High yielders (LF, and RF n= 8 and 8 respectively)]; BM-Before milking, AM-After milking, D-Difference)

Table: ib. Mean±se values of rear teat ultrasonographic variables before and after milking

		Low yielders				Medium yielders				High yielders				
		Before Milking (mm)	After Milking (mm)	Difference (mm)	Difference %	Before Milking (mm)	After Milking (mm)	Difference (mm)	Difference %	Before Milking (mm)	After Milking (mm)	Difference (mm)	Difference %	F- value
TCL	LH	11.06 ±0.85	11.56 ±0.86	0.49 ±0.09^{a}	4.43	11.0 ±0.64	11.70 ±0.67	0.67 ±0.27^{a}	6.09	13.00 ±0.45	15.19 ±0.82	2.18 ±0.55^{b}	16.8	7.63**
	RH	10.71 ±0.61	11.24 ±0.64	0.52 ±0.34^{a}	4.9	11.38 ±0.61	11.85 ±0.78	0.48 ±0.34^{a}	4.2	12.81 ±0.89	12.97 ±0.51	0.70 ±0.36^{a}	5.46	0.221^{NS}
TWT	LH	8.50 ±0.62	9.20 ±0.72	0.69 ±0.39^{a}	8.1	7.23 ±0.62	10.59 ±1.41	3.36 ±1.53^{b}	46.5	8.45 ±1.48	9.14 ±1.51	0.69 ±0.56^{a}	8.2	3.026^{NS}
	RH	8.39 ±0.55	9.10 ±0.42	0.70 ±0.36^{a}	8.3	7.06 ±0.58	8.82 ±0.75	1.92 ±0.23^{b}	27.2	7.34 ±0.59	8.41 ±0.39	1.08 ±0.300^{ab}	14.7	3.42*
TCW	LH	10.59 ±1.69	8.27 ±1.14	-2.32 ±0.63^{a}	-21.9	12.45 ±1.41	7.52 ±0.81	-4.93 ±0.45^{a}	-39.5	11.92 ±1.63	6.21 ±0.99	-5.71 ±0.799^{a}	-47.9	2.27^{NS}
	RH	7.95 ±0.99	7.30 ±0.77	-0.65 ±0.82^{a}	-8.17	9.45 ±1.17	9.87 ±1.89	-0.42 ±0.17^{a}	-4.44	9.37 ±1.51	6.63 ±0.96	-2.74 ±0.57^{a}	-29.2	0.088^{NS}
TEW	LH	21.35 ±0.70	20.90 ±0.74	-0.45 ±0.09^{a}	-2.1	21.50 ±1.45	20.5 ± 0.96	-1.44 ± 1.1^{a}	-6.69	21.12 ±0.80	21.00 ±0.71	-0.13 ± 0.28^{a}	-1.46	1.367^{NS}
	RH	21.47 ±0.55	20.19 ±1.85	-0.18 ±0.13^{ab}	-0.84	20.37 ±1.02	19.59 ±0.97	-0.82 ± 0.21^{a}	-4.02	20.57 ±0.80	20.48 ±0.82	-0.087 ±0.33^{a}	-0.42	2.809^{NS}
TWT/ TCW	LH	1.07 ±0.14	1.28 ±0.17	0.21 ±0.07^{a}	19.6	0.79 ±0.13	1.51 ±0.22	0.72 ± .18^{b}	91.1	1.19 ± 0.26	1.69 ± 0.31	0.49 ± .15^{ab}	41.2	4.103*
	RH	1.10 ±0.15	1.39 ±0.16	0.27 ±0.14^{a}	24.5	0.71 ±0.11	1.10 ±0.19	0.43 ± 0.09^{a}	60.6	0.90 ± 0.10	1.49 ± 0.26	0.59 ± 0.22^{a}	65.5	1.1048^{NS}

* (P<0.01) – Statistically highly significant, * (P<0.05) – statistically significant, NS (P>0.05) - Statistically non significant, Mean bearing same superscript are not differed significantly; [Low yielders (LH and RH n= 10 and 11 respectively); Medium yielders (LH and RH n= 7 and 7 respectively); High yielders (LH and RH n= 8 and 7 respectively)]

Fig. 1. Ultrasonography of teat: Water bath technique and Direct gel contact technique (7.5 to 12.5 MHZ linear probe)

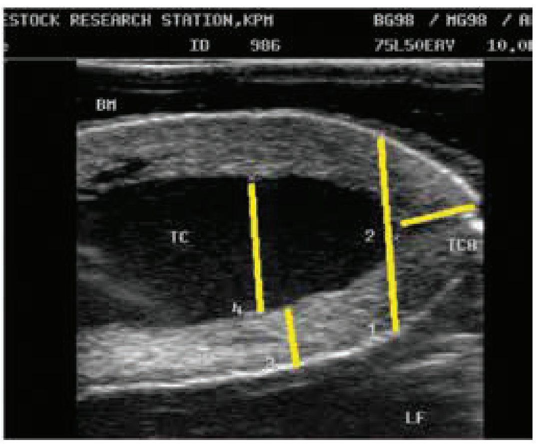

Fig.2a. Ultrasonographic measurement of normal teat before milking 1. TEW-24.2 mm, 2.TCL-8.59 mm, 3. TWT-7.13 mm, 4. TCW- 16.4 mm

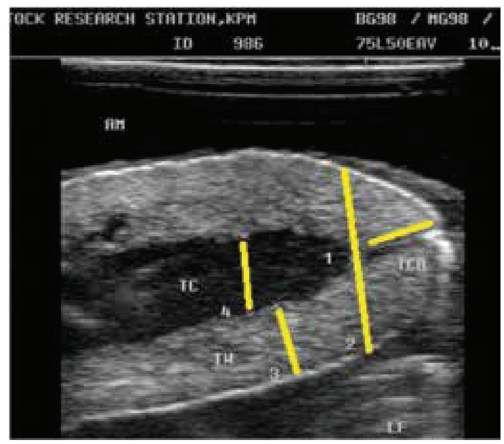

Fig. 2b. Ultrasonographic measurement of normal teat after milking 1.TCL-9.74 mm, 2.TEW-23.4 mm, 3.TWT-9.12 mm, 4.TCW-9.12 mm.

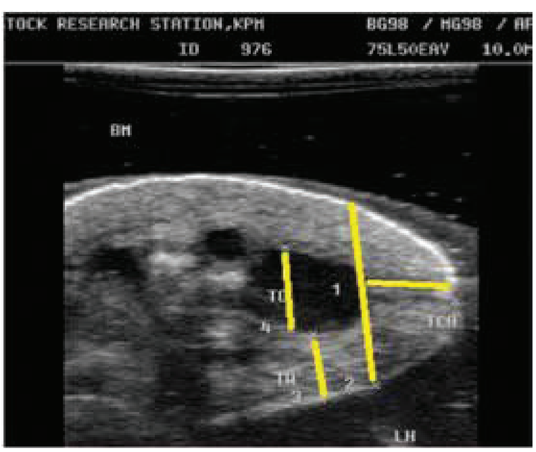

Fig.3a. Ultrasonographic measurement of Milk flow disorder affected teat before milking 1. TCL-9.76 mm 2. TEW-22 mm, 3. TWT-8.06 mm, 4. TCW- 10 mm

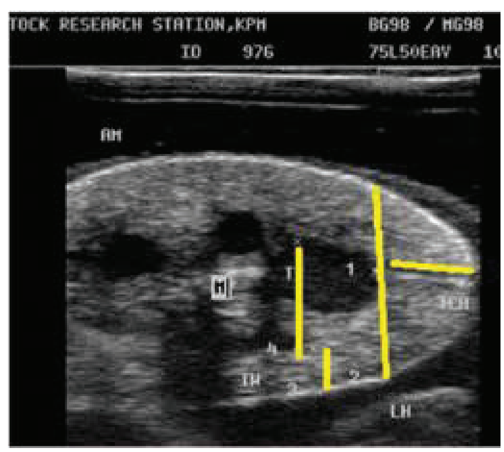

Fig.3b. Ultrasonographic measurement of Milk flow disorder affected teat after milking 1.TCL-10.1 mm, 2.TEW-22.2 mm, 3.TWT-4.93 mm, 4.TCW-12.3 mm.

Table: IIa. Mean±se values of fore teat ultrasonographic variables of cows during before and after milking in mfd affected and unaffected

		MFD affected					MFD unaffected				
		Before Milking	After Milking	Difference (mm)	Difference %		Before Milking	After Milking	Difference (mm)	Difference %	T
TCL	LF (n=6)	12.95 ±0.84	13.03 ± 0.62	0.09 ± 0.58	0.7	LF (n=26)	10.41 ± 0.53	12.11 ± 0.56	1.7 ± 0.69	16.3	1.204^{NS}
	RF (n=8)	9.72 ±0.42	10.36 ±0.38	0.67 ±0.15	6.9	RF(n=24)	12.44 ±0.63	12.81 ±0.65	0.38 ±0.35	3.05	0.47^{NS}
TWT	LF (n=6)	7.73 ± 0.82	8.96 ± 1.108	1.23 ± 1.02	15.9	LF (n=26)	7.37 ± 0.25	8.30 ± 0.33	0.93 ± 0.36	12.6	0.34^{NS}
	RF (n=8)	7.48 ±0.86	8.95 ±0.83	1.1 ±0.32	14.7	RF (n=24)	7.74 ±0.42	8.69 ±0.39	0.95 ±0.43	12.3	0.19^{NS}
TCW	LF (n=6)	10.96 ± 1.62	10.89 ± 1.58	-0.06 ± 0.24	-5.5	LF (n=26)	10.24 ± 0.83	7.90 ± 0.67	-2.33± 0.89	-22.8	1.21^{NS}
	RF (n=8)	12.33 ±1.43	10.35 ±0.88	-2.49 ±1.06	-20.2	RF (n=24)	10.84 ±0.97	8.10 ±0.93	-2.74 ±0.98	-25.3	0.14^{NS}
TEW	LF (n=6)	22.35 ± 0.95	21.86 ± 1.00	-0.48 ± 0.18	-2.1	LF (n=26)	21.62 ± 0.43	19.82 ± 0.91	-1.8 ± 0.9	-8.3	0.69^{NS}
	RF(n=8)	22.26 ±0.91	22.18 ±0.86	-0.29 ±0.09	-1.3	RF (n=24)	22.37 ±0.50	21.71 ±0.39	-0.67 ±0.23	-2.9	0.92^{NS}
TWT/ TCW	LF (n=6)	0.83 ± 0.19	0.94 ±0.19	0.11 ± 0.1	13.3	LF (n=26)	0.84 ± 0.07	1.42 ± 0.28	0.58 ± 0.29	69.0	0.75^{NS}
	RF (n=8)	0.68 ±0.12	0.93 ±0.13	0.26 ±0.08	38.2	RF (n=24)	0.92 ±0.12	1.58 ±0.27	0.67 ±0.3	72.8	0.78^{NS}

NS (P>0.05) - Statistically non significant

Table: IIb. Mean±se values of rear teat ultrasonographic variables of cows during before and after milking in mfd affected and unaffected

		MFD affected					MFD unaffected				
		Before Milking	After Milking	Difference (mm)	Difference %		Before Milking	After Milking	Difference (mm)	Difference %	T
TCL	LH (n=8)	12.46 ±1.4	12.83 ± 1.28	0.37 ± 0.26	2.96	LH (n=25)	11.50 ± 0.44	12.57 ± 0.56	1.07 ± 0.25	0.093	1.41^{NS}
	RH (n=6)	10.42 ±0.46	10.81 ±0.54	0.39 ±0.2	3.7	RH (n=25)	11.86 ±0.42	11.90 ±0.54	0.04 ±0.39	0.33	0.58^{NS}
TWT	LH (n=8)	7.36 ± 0.73	8.24 ± 0.88	0.87 ± 1.11	11.8	LH (n=25)	8.10 ± 0.57	9.32 ± 0.67	1.22 ± 0.51	15.1	0.31^{NS}
	RH (n=6)	8.73 ±0.65	9.76 ±0.64	1.03 ±0.36	11.7	RH (n=25)	7.26 ±0.37	8.48 ±0.28	1.22 ±0.23	16.8	0.4^{NS}
TCW	LH (n=8)	10.48 ± 1.72	10.16 ± 1.92	-0.33 ± 1.89	-3.1	LH (n=25)	9.34 ± 0.70	7.14 ± 0.56	-2.2 ± 0.51	-23.6	1.37^{NS}
	RH (n=6)	9.99 ±1.18	8.65 ±1.23	-1.34±0.36	-13.4	RH (n=25)	9.81 ±0.77	7.78 ±0.76	-2.03 ±0.48	-20.6	0.74^{NS}
TEW	LH (n=8)	21.94 ± 0.56	20.93 ± 0.62	-1.01 ± 0.34	-4.6	LH (n=25)	21.12 ± 0.53	20.44 ± 0.45	-0.68± 0.33	-3.21	0.51^{NS}
	RH (n=6)	21.27 ±0.69	20.96 ±0.65	-0.31±0.14	-1.5	RH (n=25)	20.61 ±0.50	19.46 ±0.74	-0.42 ±0.19	-2.0	0.28^{NS}
TWT/ TCW	LH (n=8)	0.93 ± 0.25	1.35 ± 0.55	0.42 ± 0.53	45.2	LH (n=25)	1.03 ± 0.11	1.47 ± 0.13	0.45 ± 0.09	43.6	0.1^{NS}
	RH (n=6)	0.95 ±0.14	1.25 ±0.16	0.3 ±0.08	31.6	RH (n=25)	0.85 ±0.076	1.33 ±0.13	0.48 ±0.12	56.5	0.81^{NS}

NS (P>0.05) - Statistically non significant in MFD affected teats than MFD unaffected teats after milking. It was found after meticulous and extensive screening of literatures that there were no published reports available in this aspect. Hence, assumptions are made that the difference could be due to the differences in hand milking techniques adopted by the milkers (stripping or by full hand method).

The teat cistern width in all the teats were found to be decreased in both MFD affected and unaffected cows after milking. This study also revealed that after milking values in MFD unaffected teats were found to decrease than the values for corresponding teats in MFD affected group. Decreases in the teat cistern width after milking were reported by Neijenhuis *et al.,* (2001). Studies on milk flow disorders revealed that milk is being retained in the teat cistern signifying that the teat cistern width may not decrease when compared to MFD unaffected teats as observed by Querengässer *et al.,* (2002). In this study the ultrasound parameters were also suggestive of milk retention in MFD affected teat. The teat end width was found to be decreased after milking in the entire teat in both MFD affected and unaffected teat. Neijenhuis *et al.,* (2001) reported of increase in teal wall thickness after machine milking in healthy teats. Teat end width (TEW) decrease was more in MFD affected teats than unaffected teats except for left hind teat. The differences recorded might be due to the fact that measurements are being carried out at the most pliable part of the teat.

From the current study, Ultrasonography of the teat was found to have better diagnostic yield in the detection of MFD (64.28% (18/28)) when compared to clinical detection (35.75 % (10/28)). Teat ultrasonography has the advantage for localization of the lesions and in identifying the type of lesions. Ultrasonography of the teat can be included as one of the parameter in selection of good quality dairy cattle as well as probable high yielder cows. No published reports are available on ultrasonography of teat with regard to milk flow disorders especially in hand milked cows. Hence the current ultrasonographic teat parameters gains significance; however further study in a larger sample sizes for different Indian breeds, for utilization of ultrasound for high yielding dairy cattle selection in India.

Conclusions

The values of ultrasonographic variables for teat parameters were found to increase after milking compared to those before milking; but they were statistically non significant. The increase in the measurements indicates that the time taken for recovery of the teat to normalcy was more, thereby exposing the teat for possible infections. Further study on various Indian breeds will help in establishing a robust mastitis and milk flow disorder control programmes. Ultrasonography of the teat needs to be included in diagnosis and management of MFDs, as there is a higher detection rate with ultrasound with clinical examination alone.

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