Transferosomes the Nano Novel Vesicular Carrier for Skin Cancer.

J Komathy[1], S Sangeetha[*1], H Gayathri[1]

[1]Department of Pharmacy, SRM College of Pharmacy, Chennai, Tamil Nadu.

Abstract

Transferosomes creating a new development in delivering a drug through skin. In oral, parenteral drug delivery system shows poor patient compliance are the major complication in clinical practice. Well, Transdermal route has obtained an appreciable interest in pharmaceutical research. Transferosomes consist of both hydrophobic, hydrophilic moieties together results, the drug molecule with wide range of solubility and possess flexible Nano-vesicles formulation comprise of lipid and surfactant. It offers a versatile delivery concept for improving stability, potential for active compound. Major advantages in transferosomes are: avoidance of first pass metabolism, improve patient compliance, improve bioavailability, painless, and reduce frequency of administration. They can pretence as a carrier towards low and additionally high molecular drugs. Skin cancer occurs due to abnormal growth of skin cells it is a common diseases found in white skin. Current study shows that transferosomes are drug mover system that can penetrate beyond undamaged with skin stratum corneum and epidermis expands osmotic gradient foremost to penetrate the transferosome beyond the skin. Over the past few years in research has proven that Transferosomes are the fast developing one in clinical studies.

Keywords: Transferosome, Mechanism of transferosomes, Skin cancer, Patches mechanism, Application, transferosome works on skin cancer mechanism.

Accepted on 06 January, 2022

Introduction

It is a supramolecular system that can proceed through a barrier of permeability and transport a substance from other site. It may be recount as lipid droplet of such deformability that tolerates an easy penetration through pores as much smaller than droplet size. It has been popularly worn as novel carrier towards effectual Transdermal drug delivery system.4 It enrich the penetration of most of the low too high molecular weight drugs and it can reaches up to 90%. [9]They are flexible Nano-vesicles formulations form of lipid and surfactant. The appearance of surfactant in their structure, which helps in solubilizing stratum corneum, transferosomes has outstanding skin permeation power. Further, it has acquired massive demand in last few years owing to sustained and well organized delivery of low and higher molecular weight drugs. [1]Transferosomal drug delivery has a superior capacity to encapsulate both hydrophilic and lipophilic drugs without any toxicological effect. As well as being convenient and reliable, impart several privilege such as avoiding of GI incompatibility, variable GI absorption, and evading of first-pass metabolism, upgrade bioavailability, reducing the pace of administration, enhance patient conformity, and has fast drug input lapse. Different perspectives have been suggested to elevate the stability of vesicular system; [5]Transferosomes furnish a versatile delivery concept for better stability furthermore ability to be pre-owened with a wide range of active compounds. They are metastable, which builds up the vesicle membrane to be ultra-flexible and thus, the vesicles are extremely deformable pores compressing less than one-tenth of their own diameter when applied under non-occlusive conditions. [6]Thus, uniform dimension up to less than-300 nm can penetrate and undamaged the skin.

The immune Anatomy and Physiology of Skin: 5 the skin is thick outer tissue covers vertebrates with three main function defence, balance, and perception. It is an outer covering layer of the body and largest organ of the integumentary system. Skin has many histological layers divided in to: Epidermis, dermis, subcutaneous tissue.

Epidermis: 5 It is an outermost layer of the skin and contain number of layers are: stratum germinativum (basal layer), stratum spinosum, stratum granulosum (above layer), and stratum corneum.

Dermis: [5]It gives physiological support for epidermis. And major element of human skin about 3-5 mm thickness may be delivering more lipophilic molecule.

Subcutaneous tissue: [5] It is the fattest layer as well furnishes the accessible supply of high energy molecule.

Function of Skin: It involves shielding against water loss, Protection from physical, chemical, microbial injury give rise to external agent. The protective function of the skin is intensify by the presence of sebum and sweat that spreads on top of the cells of stratum corneum. It requires vitamin D synthesis by help of sunlight. And displays thermoregulation process.

Advantage of Transferosomes

1. It shows considerable penetration of drug owing to skin because of its flexible membrane.

2. It assist as conveyor for both small and higher molecule weight drugs eg: anticancer, insulin,anesthetic.

3. % of drug entrapment is more in case of lipophilic drugs.

4. These are biodegradable, biocompactbile as they prepare with natural phospholipids.

5. They may use both systemic and topical drug delivery. 10

Disadvantage of Transferosomes

1. Because of oxidative degradation, they are chemically unstable.

2. The formulation and processing aspects of transferosomes are costly.

3. Lack of purity of natural phospholipids.10

Salient Features of Transferosomes

1. Transferosomes are house drug molecule having wide range of solubility because of their framework that contain hydrophilic, hydrophobic together in it.

2. Transferosomes give a better penetration of vesicles due to high deformability[45]. They are made up of natural phospholipids.

3. Both systemic and topical delivery of drugs through transferosomes is possible.

4. Transferosomes release their content slowly in gradual manner act as warehouse.

5. The formulation of transferosomes is very simple, does not have any lengthy procedure hence, transferosomes are easy to scale up. [46]

Mechanism of Transferosomes It involves the penetration for mechanism is osmotic gradient occurs because of evaporation of water term appeal lipid suspension on skin surface. It has stronger bilayered deformability and has enlarged empathy to bind and hold water. It is highly hydrophilic and elastic deformation vesicles permanently follow prevention of dehydration. When they applied on an extended biological surface, it tends to penetrate its barrier. Normal variation in Tran's epidermal water content gradient qualifies them to deliver and initiate huge epidermal layers along with dehydration of lipid vesicles in stratum corneum. Therefore, transferosome uptake is operated by hydration gradient which exist beyond the epidermis, stratum corneum. Barrier penetration shows reversible bilayer deformation, yet it does not balance the vesicle interigrity or barrier properties, for hydrating affinity and gradient to persist in place. [6, 7]

Table 1. *Materials.*

Class	example	uses
Phospholipids	Phosphatidylcholine, Egg phosphotidylcholine, Dipalmitoylphosphatidylcholine	Formation of vesicles
Surfactant	Sodium cholate, Tween-80, Span-80, Tween-20, sodium deoxycholate	To provide flexibility
Alcohol	Ethanol, Methanol, Chloroform	Solvent agent
Buffering agent	Salinephosphate buffer (pH 6.4), Phosphate buffer (pH 7.4)	Hydrating medium
Dye	Rhodamine-123, Fluorescence-DHPE Nile- red, Rhodamine-DHPE	Approach of CSLM study5,7

Methods involved in Transferosomes

1. Vortexting sonication method[6, 10]

2. Suspension homogenization process [10]

3. Modified handshaking process

4. Centrifugation processes

5. Thin film hydration technique [12]

6. Rotatory vacuum evaporator method [6, 12]

Thin Film Hydration Technique

The sufficient quantity of soya lecithin and surfactant is added in round bottom flask and dissolved *via* shaking either chloroform, ethanol. AT 25°C 600 mm/hg pressure and 100 rpm, the thin film was set up by rotatory evaporation for around 15 minutes. To dry the film a vacuum is applied for an hour. The drug is added and dissolved in 7.4 pH phosphate buffer about 10 ml and heated up to around 55°C. Then the film was hydrated by the handshaking process occurs half an hour with warmed buffer, mixture was agitated by half an hour by orbital shaker and it was perceive under microscope and suspension which set aside in refrigerator at 4°C.12

Rotary Vacuum Evaporation

Mixture of vesicles, initiate an ingredient like surfactant, phospholipids which are dissolved in solvent like (methanol, ethanol) in round bottom flask. Organic solvent is seperated at room temperature (20°C) using rotory evaporator leaving thin layer of solid mixture that is settled on the wall of the flask. Dried surfactant film can be rehydrated with aqueous phase (phosphate buffer saline) at 0-60°Cwith moderate stirring in rotary evaporator for about 30 mins. Then the mixture was sonicated in bath sonicator for 1 hour. [6,12]

Characterization of Transferosomes

Entrapment Efficiency

It indicate the % entrapment of the drug is added and requires drug by using mini-column centrifugation following separation of unentrapped drug, these vesicles became distributed by utilize of 0.1% triton× -100 (or) 50% n propanol 5

Entrapment efficiency= (amount entrapped/ total amount added)*100.

Vesicle diameter

This method may insist by make use of spectroscopy photon correlation and process of dynamic light scattering (DLS)

method. Sample is formulated in distilled water and filtered by way of membrane filter 0.2 mm and diluted in filtered saline therefore, the measurement of size is concluded *via* spectroscopy of photon correlation, dynamic light scattering (DLS) measurements.5

Penetration Ability

It can be analyzed by using fluorescence microscopy for penetration ability.5

No of Vesicles per Cubic Meter

It is the most dominant parameter for progressing framework of other proceeding variable. Unsonicated transferosome formulations are diluted 5 times wi th 0.9% Nacl solution. Haemocytometer and optical microscope have been preowned for this study. 5, 10

In-Vitro Drug Release

This study executes to demonstrate the permeation rate. Time is requiring accomplishing the steady state. Transferosome suspension is incubated at 32°C and samples are taken at individual time intervals and amount of drug release is determined secondary to the amount of drug trapped at 0 times as the initial amount of drug release is isolated by centrifugation.10

Measurement of Turbidity

Drug turbidity in aqueous solution, probably measured by means of nephlometer.5

Skin Deposition Studies on Optimised Formulation

Surface of goat skin after the end of 24 hours permeation study, which is washed for 5 times with a solution that contains PBS (pH 7.4) in ratio 1:1 ratio besides, washing it with water the spare drug present on surface is removed. Ethanol and buffer solution having the range of pH 7.4 is used to cut the skin into small pieces after homogenization. It is then remain at room temperature for 6 hours. The drug content is determined by using appropriate phosphate buffer dilutions (pH 7.4) after shaking and centrifuging it at 500 RPM for 5 minutes. By Using T test results are compared with that of the control. 47

Skin Cancer

It is the abnormal growth of skin cells and well established malignant disease found in Caucasians (white skinned). These are foremost part evolve in areas that are exposed to sun, yet it can else formed in places that don't normally sun get exposure exceeding over 5.4 million cases were reported worldwide in every year. Different types of skin cancers are named after the cell that are originated and their clinical behaviour 14. Most common types are:

- Basal cell carcinoma
- Squamous cell carcinoma
- Malignant melanoma
- Non- malignant melanoma

How Transferosomes Works on Skin Cancer

The current investigation shows that the transfersomes are drug moving mechanism which really penetrate, beyond undamaged within the skin. It was assumed that two factors were identified by unimpeded movement of such carriers: high elasticity (deformability) of the bilayer vesicles and the fact that the osmotic gradient beyond skin and carry drug over the whole skin. To resolve some of these issues in skin, a novel type transferosomes are supremely deformable lipid vesicle which has been announced latterly to go through unbroken skin. Skin function as a buffer,restricting the release of treatment modality transcutaneous. There have been modern vesicular systems which are far more elastic than vesicular system in serval aspects. Edge activator, phospholipids, sodiumcholate, constitutes transferosomes and is applied in non-occulsive manner. Lipid residue and proximal water which makes the lipid to pull the water molecules insist the hydrating &lipid vesicles to move from site of higher water concentration to lower water concentration. Transdermal osmotic gradient superior to the penetration of the transferosome over the skin is expanded by variation in water content over the skin stratum corneum and epidermis . Transferosomes gives that the variety of composition the crucial attribute of their application in order to maximize permeability and range of therapeutic molecules. [6]

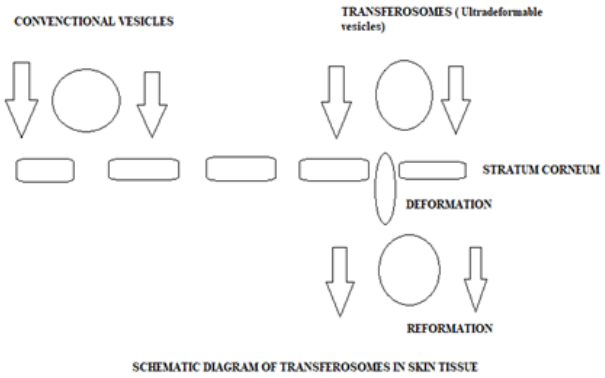

Figure 1. *Schematic diagram of Transferosomes in Skin tissue.*

Table 2. *Drugs for Skincancer.*

For Basal Cell Carcinoma	(Aldara) Imiquimod
	(Erivedge) Fluorouracil
	Sonidegib
For Squamous Cell Carcinoma	Libtayo
	Cemiplimab
For Melanoma	Dacarbazine
	Nivolumab
	Proleukin
For Markel Cell Carcinoma	Avelumab
	Bavencio
	Pembrolizumab

Transverses Vs Other Carrier

Liposomes Vs Transferosomes

In functional terms, transferosomes differs from commonly pre-owned liposomes, they are extra flexible, adaptable due to edge activator. The very elevated flexibility of membrane allows transferosome compress themselves in pores which were smaller than their concede diameter. It occurs owing more elasticity of transfer some membrane involves combining atleast two lipophilic components with enough different packaging with single bilayer. This involves resulting of aggregated deformability allows transferosomes to penetrate in skin instantly.[7]

Penetration Ability

To convert the penetration ability of all carrier system can be done by dispersal profiles of fluorescently categorize by mixed lipid micelles, both liposome, transferosome are measured by Confocal Scanning Laser Microscopy (CSLM) in unbroken murine skin, vesicles with really deformable transfer some across stratum corneum enters in to epidermis.[7]

Application of Transferosomes

Delivery of Insulin

Ttransferosomes, the wealthy valid of non-invasive therapeutic wield comparable as higher molecular weight drugs on skin. Generally, insulin is dispensed by subcutaneous route. Encapsulation of insulin within transferosomes gets the better of this entire problem. The composition of the carrier also first intimate the hyperglycemia was announced after (90-180) minutes. Some other, Anti-diabetic drugs are also being studied to improve the skin permeation. [6]

Delivery of Anesthetics

A) Mahmoud M Omar et al. Studied on Preparation and optimization of lidocaine transferosomal gel containing permeation enhancers: a hopeful perspective improvement of skin permeation. Aim of author is to develop a tropical gel containing lidocaine that can give out as an alternative to high pain and give rise to local anaesthetic injections. Gelling agent used in the formulation was HPMC k^{15}. Viscosity, Drug content, ex-*vivo* permeation was also evaluated for the gel formulation. Tail flick test is used to evaluate the analgesic effect on the gel. Results show increase in analgesic action as well as skin permeation effect of topical gel containing transfersomal lidocaine.[16]

B) Planas ME et al. Studied on Non-invasive percutaneous induction by a new form of drug carrier of topical analgesia and prolongation of local pain insensitivity. In this study, duration of action, permeability of local anaesthetics, common analgesics were put in dermally on rats and humans in form of transfersomes. Permeability and duration of action were studied. They shows that transfersomes provides a promising method for non-invasive treatment of local pain as they were direct topical drug application. The corresponding subcutaneous injection of similar drugs were found to have same potency for dermally applied anaesthetics.[41]

Delivery of Anti-Cancer Drugs

A) Drugs such as methotrexate were endeavour for transdermal technology utilizes transdermal delivery and result was favorable and it shows new approach for treatment especially for skin cancer.[7]

B) Lu Y et al. Studied on Transdermal and lymph targeting transfersomes of vincristine. For their study, drug Vincristine is used to treat leukemia and hogkin /non-hogkin lymphoma were taken. On the conflicting, its clinical use has been restricted due to its neuro toxicity and local stimulation. The aim of their study is to decrease its side effects and also increase their curing effects. Ultra-sonic dispersion, dry film method were also used to prepare transfersome loaded with Vincristine. Targeting ability, pharmaceutical properties and pharmacokinetic characters of the Vincristine were determined by using HPLC method. In their study, they were concluded that transfersomes have positive lymph targeting ability.[42]

Delivery of Protein& Peptides

A) When given through oral routes it degrades easily, when they are large in size it is difficult to administer. Transferosomes have found same bioavailability as that of subcutaneous injection for delivering a protein in suspension.

B) De Marco Almeida et al. Studied on Physicochemical Characterization and Skin Permeation of Synthetic peptide PnPP-19 comprises Cationic Transfersomes. In their study PnPP-19, a synthetic peptide consisting 19 aminoacids were used in treatment of erectile dysfunction. They aimed to develop and evaluate the skin permeation ability of PnPP-19 as well as PnPP laden transfersomes, different types of liposomal preparation methods were evaluated. From their study it was concluded that, Transferosomes were able to protect the peptide from degradation and it is recommend for tropical administration.

Delivery of Nsaid Drugs

Sureewan Duangjit et al, studied the characterization in vitro skin permeation of Meloxicam loaded liposomes vs transferosomes. Their study intricate transdermal delivery of Meloxicam (MX) using transferosome and liposome to evaluate their prospective use. The capacities of skin permeation MX loaded transferosomes were found to be high when compared to MXloaded liposomes. MX loaded transferosomes undergo many evaluation parameters like particle size, zeta potential, loading efficiency. Stratum corneum lipid is dispense by transferosomes that is clearly designate Differently Scanning Calorimetry (DSC), Fourier Transform Infrared spectroscopy (FT-IR). It shows transferosomes are prospectively acceptable for transdermal drug delivery system. [44]

Conclusion

Transdermal drug delivery is more covenants, painless and prospects the virtual way to deliver the constant doses of many medications. Wide range of drugs that can be delivered and improves, the Minimal drug uptake complications, side effects with low cost and easy to use. Transdermal delivery of a drug product is contemporary accepted as oral dosage form and permit the illusion of first pass metabolism. New Nano technological method shows cytostatic delivery systems, efficient tumour targeting and thereby lessen adverse effects with extend effective therapies, and increases the life of skin cancer patients. New pharmaceuticals collaborate with enhance method of distribution for a contemporary advance field will be assuredly build on the treatment for skin cancer patients, upgrading the level for living or their recovery of pretentious people. Healthcare practitioners would achieve precise novel diagnostics, accessible therapeutic possibilities through such evaluation. These transferosomes holds a smart way and favourable future in Transdermal Drug Delivery System.[47, 48]

References

1. Gupta A, Aggarwal G, Singla S, et al. Transfersomes: a novel vesicular carrier for enhanced transdermal delivery of sertraline: development, characterization, and performance evaluation. Scientia pharmaceutica. 2012; 80(4):1061-80.
2. Prabhakar D, Sreekanth J, Jayaveera KN. Transdermal drug delivery patches: a review J. Drug Deliv. Ther. 2via13; 3(4):231-21.
3. Thakur N, Jain P, Jain V. Formulation Development and Evaluation of transferosomal gel. J. Drug Deliv. Ther. 2018; 8(5):168-77.
4. Reddy YD, Sravani AB, Ravisankar V, et al. Transferosomes a novel vesicular carrier for transdermal drug delivery system. J. Innov. Pharm. Biol. Sci. 2015; 2(2):193-208.
5. Eldhose MP, Mathew F, Mathew NJ. Transfersomes-a review. Int. j. pharm. Pharm. Sci. 2016; 6:436- 52.
6. Rai S, Pandey V, Rai G. Transfersomes as versatile and flexible nano-vesicular carriers in skin cancer therapy: the state of the art. Nano reviews & experiments. 2017; 8(1): 1325708.
7. Modi CD, Bharadia PD. Transfersomes: new dominants for transdermal drug delivery. Am J Pharm Tech Res. 2012; 2(3):71-91.
8. Qushawy M, Nasr A, Abd-Alhaseeb M, et al. Design, optimization and characterization of a transfersomal gel using miconazole nitrate for the treatment of candida skin infections. Pharmaceutics. 2018; 10(1):26.
9. Abdallah MH, Lila AS, Anwer MK, et al. Formulation, Development and Evaluation of Ibuprofen Loaded Nano-transferosomal Gel for the Treatment of Psoriasis. Int. J. pharm. Sci. Res. 2019;21:1-8.
10. Chaurasiya P, Ganju E, Upmanyu N, et al. Transfersomes: a novel technique for transdermal drug delivery. J. Drug Deliv. Ther. 2019;15; 9(1):279-85.
11. Alkrad JA, Alruby AS. Nonionic microemulsions for oral and transdermal delivery of gentamicin. Die Pharmazie-Int. J. pharm. Sci. 2018; 73(1):9-15.
12. Sailaja K, Supraja R. Formulation of mefenamic acid loaded transfersomal gel by thin film hydration technique and hand shaking method. Nanomedicine Journal. 2017; 4(2):126-34.
13. Tejaswini K, Swapna S, Madhu AB, et al. Formulation and evaluation of fluconazole loaded transfersome gel. Int J Sci. 2016; 3(3):1-4.
14. Orthaber K, Pristovnik M, Skok K, et al. Skin cancer and its treatment: novel treatment approaches with emphasis on nanotechnology. Journal of nanomaterials. 2017; 2017.
15. Janga KY, Tatke A, Dudhipala N, Balguri SP, Ibrahim MM, Maria DN, Jablonski MM, Majumdar S. Gellan gum based sol-to-gel transforming system of natamycin transfersomes improves topical ocular delivery. J. Pharmacol. Exp. Ther. 2019; 370(3):814-22.
16. Omar MM, Hasan OA, El Sisi AM. Preparation and optimization of lidocaine transferosomal gel containing permeation enhancers: a promising approach for enhancement of skin permeation. Universal Journal of Pharmaceutical Research. 2019;14:155
17. Chauhan N, Kumar K, Pant NC. An updated review on Transfersomes: a novel vesicular system for transdermal drug delivery. Univers. J. Pharm. Res. 2017;2(4):49-52.
18. Kumavat SD, Chaudhari YS, Borole P, et al. Transfersomes: a promising approach for Transdermal drug delivery system. Asian J. Pharm. Sci. 2013; 3(5):1-7.
19. Pawar AY. Transfersome: A novel technique which improves transdermal permeability. Asian J. Pharm. Sci. 2016; 10(04).
20. Khan MA, Pandit J, Sultana Y, et al. Novel carbopol-based transfersomal gel of 5-fluorouracil for skin cancer treatment: in vitro characterization and in vivo study. Drug Deliv. 2015; 22(6):795-802.
21. Shukla KV, Meshram R, Yadav M. Formulation, Development and Evaluation of Transpersonal Gel of Metronidazole. J drug deliv ther. 2019; 9(4):642-5.
22. Goyal N, Thatai P, Sapra B. Skin cancer: symptoms, mechanistic pathways and treatment rationale for therapeutic delivery. Ther. Deliv. 2017; 8(5):265-87.
23. Chaurasia L, Singh S, Arora K, et al. Transferosome: A Suitable Delivery System for Percutaneous Administration. Current Research in Pharmaceutical Sciences. 2019;8:1-1.
24. Miatmoko A, Kumi K, Hattori Y. Evaluation of transfersome and protransfersome for percutaneous delivery of cisplatin in hairless mice. J Pharm. Pharmacol. 2015; 5(1):1-7
25. Venkatesh DN, Kalyani K, Tulasi K, et al. Transfersomes: a novel technique for transdermal drug delivery. International Journal of Research in Pharmaceutical and Nano Sciences. 2014;3(4):266-76.
26. Das P, Deshmukh N, Badore N, et al. A Review Article on Melanoma. Journal of pharmaceutical sciences and research. 2016;8(2):112.

27. Jiang T, Wang T, Li T, et al. Enhanced transdermal drug delivery by transfersome-embedded oligopeptide hydrogel for topical chemotherapy of melanoma. ACS Nano. 2018; 12(10):9693-701.
28. Ali SS, Gudipati M, Nadendla R. Development and characterization of miconazole nitrate transfersomal gel. International Journal of Research in Pharmaceutical Sciences and Technology. 2020; 1(4):109-16.
29. Sivannarayana P, Rani AP, Saikishore V, et al. Transfersomes: ultra-deformable vesicular carrier systems in transdermal drug delivery system. Res. J. Pharma. Dosage Forms and Tech. 2012; 4(5):243-55.
30. Jangdey MS, Gupta A, Saraf S, et al. Development and optimization of apigenin-loaded transfersomal system for skin cancer delivery: in vitro evaluation. Artificial cells, nanomedicine, and biotechnology. 2017; 45(7):1452-62.
31. Sharma N, Agarwal G, Rana AC, et al. A review: transdermal drug delivery system: a tool for novel drug delivery system. Int J drug dev Res. 2011; 3(3):70-84.
32. Walve JR, Bakliwal SR, Rane BR, et al. Transfersomes: a surrogated carrier for transdermal drug delivery systemInt J Appl Biol Pharm. 2011; 2(1):204-13.
33. D'Orazio J, Jarrett S, Amaro Ortiz A, et al. UV radiation and the skin. Int. J. Mol. Sci. 2013; 14(6):12222-48.
34. Smeets NW, Krekels GA, Ostertag JU, et al. Surgical excision vs Mohs' micrographic surgery for basal-cell carcinoma of the face: randomised controlled trial. The Lancet. 2004; 364(9447):1766-72.
35. Gallagher RP, Hill GB, Bajdik CD, et al. Sunlight exposure, pigmentary factors, and risk of nonmelanocytic skin cancer: I. Basal cell carcinoma. Arch. Dermatol.1995; 131(2): 157-63.
36. Hartevelt MM, Bavinck JN, Kootte AM, et al. Incidence of skin cancer after renal transplantation in the Netherlands. Transplantation. 1990 Mar; 49(3):506-9.
37. Akgul B, Cooke JC, Storey A. HPV-associated skin disease. The Journal of Pathology.2006 Jan; 208(2):165-75.
38. Meng S, Zhang C, Shi W, Zhang xw, et al. Preparation of osthole-loaded nano-vesicles for skin delivery: characterization, in vitro skin permeation and preliminary in vivo pharmacokinetic studies. Eur J Pharm Sci. 2016; 92:49-54.
39. SHINGADE GM. Review on: recent trend on transdermal drug delivery system. Journal of drug delivery and therapeutics.2012; 2(1).
40. Simoes MF, Sousa JS, Pais AC. Skin cancer and new treatment perspectives: A review. Cancer letters. 2015; 357(1):8-42.
41. Planas ME, Gonzalez P, Rodriguez L, Sanchez S, Cevc G. Noninvasive percutaneous induction of topical analgesia by a new type of drug carrier, and prolongation of local pain insensitivity by anesthetic liposomes. Anesthesia and analgesia. 1992; 75(4):615-21.
42. lu y, hou sx, zhang lk, et al. transdermal and lymph targeting transfersomes of vincristine. yao xue xue bao. acta pharmaceutica sinica. 2007; 42(10):1097-101.
43. De Marco Almeida F, Silva CN, de Araujo Lopes SC, et al. Physicochemical characterization and skin permeation of cationic transfersomes containing the synthetic peptide PnPP-19. Current Drug Delivery. 2018; 15(7):1064-71.
44. Duangjit S, Opanasopit P, Rojanarata T, et al. Characterization and in vitro skin permeation of meloxicam-loaded liposomes versus transfersomes. J Drug Deliv. 2011.
45. Elsayed MM, Abdallah OY, Naggar VF, Khalafallah NM. Deformable liposomes and ethosomes as carriers for skin delivery of ketotifen. Die Pharmazie Int. J. Pharm Sci. Res. 2007; 62(2):133-7.
46. Cevc G, Blume G, Schätzlein A. Transfersomes-mediated transepidermal delivery improves the regio-specificity and biological activity of corticosteroids in vivo. J Control Release. 1997; 45(3):211-26.
47. Bhasin B, Londhe VY. An overview of transfersomal drug delivery. Int J Pharm Sci Res. 2018; 9(6):2175-84.

*Correspondence to:

Dr. S Sangeetha

Department of Pharmacy

SRM College of Pharmacy

Chennai

Tamil Nadu

India